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February 26, 2001

Administrator
US EPA
P.O. Box 1473
Merrifield, VA 22116
Attn: Chemical Right-to-Know Program

Dear Ms. Browner:

On behalf or the member companies of the Terpene Consortium, the Flavor and Fragrance High Production Volume Consortia is pleased to resubmit the Test Plan and Robust Summaries for the chemical category designated the "Primary Terpenoid Alcohols and Related Esters". The Terpene Consortium has chosen not to belong to the HPV Tracker System for submission of test plans and robust summaries. We are therefore submitting the test plan and accompanying robust summaries directly to EPA to make available to the public.

This submission includes one electronic copy in pdf. format. A second electronic copy and hard copy will be sent to the EPA HPV robust summary submission address. The EPA registration number for the Terpene Consortium is

Please feel free to contact me with any questions or comments you might have concerning the submission (tadams@therobertsgroup.net) or 202-331-2325).

Sincerely,

Timothy Adams, Ph.D.
Technical Contact Person for FFHPVC

The Flavor and Fragrance High Production Volume Consortia

The Terpene Consortium

Test Plan for Terpenoid Primary Alcohols and Related Esters

3,7-Dimethyl-6-octen-1-ol (dl-Citronellol)	**CAS No. 106-22-9**
***trans*-3,7-Dimethyl-2,6-octadien-1-ol (Geraniol)**	**CAS No. 106-24-1**
***cis*-3,7-Dimethyl-2,6-octadien-1-ol (Nerol)**	**CAS No. 106-25-2**
Acetylated myrcene (Process name for mixture containing *cis*-and *trans*-3,7-dimethyl-2,6-octadien-1-yl acetate)	**CAS No. 68412-04-4**

FFHPVC Terpene Consortium Registration Number 1101125

Submitted to the EPA under the HPV Challenge Program by:

The Flavor and Fragrance High Production Volume Chemical Consortia

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Bush Boake Allen, Incorporated

Citrus and Allies Essences, LTD

Givaudan Roure

ICI Americas

International Flavors and Fragrances Inc.

J. Manheimer Incorporated

Hercules Chemical

Millennium Chemicals, Inc.

TECNAL Corporation

Universal Flavor Corporation

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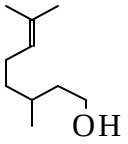
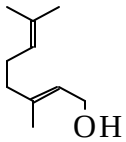
The HPV Challenge Test Plan for Terpenoid Primary Alcohols and Related Esters

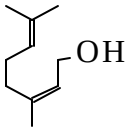
1 Identity of Substances



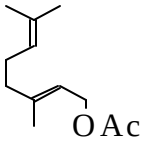
3,7-Dimethyl-6-octen-1-ol
(dl-Citronellol)
CAS No. 106-22-9



***trans*-3,7-Dimethyl-2,6-octadien-1-ol**
(Geraniol)
CAS No. 106-24-1



***cis*-3,7-Dimethyl-2,6-octadien-1-ol**
(Nerol)
CAS No. 106-25-2



***trans*-3,7-Dimethyl-2,6-octadien-1-yl acetate**
(Acetylated myrcene - principal component)
CAS No. 68412-04-4

2 Category Analysis

2.1 Introduction

In October of 1999, members of the U.S. flavor and fragrance industries and other manufacturers that produce source materials used in flavors and fragrances formed consortia of companies in order to participate in the Chemical Right-to-Know Program. Members of these consortia are committed to assuring the human and environmental safety of substances used in flavor and fragrance products. The consortia are organized as the Flavor and Fragrance High Production Volume Consortia (FFHPVC). The Terpene Consortium, as a member of FFHPVC serves as an industry consortium to coordinate testing activities for terpenoid substances under the Chemical Right-to-Know Program. Twelve (12) companies are current members of The Terpene Consortium. The Terpene Consortium and its member companies are committed to assembling and reviewing available test data, developing and providing test plans for each of the sponsored chemicals, and, where needed, conducting additional testing. The test plan, category analysis and robust summaries presented below represent the first phase of the Consortium's commitment to the Chemical Right-to-Know Program.

2.2 Background Information

The chemical category designated "Terpenoid Primary Alcohols and Related Esters" includes three terpenoid acyclic aliphatic primary alcohols, citronellol, geraniol, and nerol. The category also includes a mixture of terpenoid esters and alcohols called acetylated myrcene. Geranyl acetate and neryl acetate are the principal products formed when myrcene is acetylated. Thus, the mixture is commonly recognized as acetylated myrcene. The four substances are grouped together because of their close structural relationships and the resulting similarities of their physio-chemical and toxicological properties. In nature, terpenes are produced by the isoprene pathway that is an integral part of normal plant and animal biosynthesis. Oxygenated terpene substances {e.g., geraniol, nerol, citronellol, citral (a mixture of geranial and neral), and geranyl acetate} are therefore, ubiquitous in the plant kingdom. They are also common components of

traditional foods. Quantitative natural occurrence data indicate that oral intake of these substances occurs predominantly from consumption of food in which they occur naturally [Stofberg and Grundschober, 1987; Stofberg and Kirschman, 1985]. Greater than 500,000 pounds (lbs) of citral, citronellol, geraniol, nerol, and related esters are consumed annually as natural components of food in the United States. Less than 25,000 lbs of the four substances in this chemical category are consumed annually as added flavoring substances in the United States [Stofberg and Grundschober, 1987]. Citronellol, geraniol, nerol, and geranyl acetate are currently recognized by the U.S. Food and Drug Administration (FDA) as GRAS ("generally regarded as safe") for their intended use as flavoring substances [Hall and Oser, 1965].

In addition, geraniol is endogenous in animals. As the pyrophosphate and coenzyme A (CoA) esters, geraniol is present in all cells as an intermediate in cholesterol biosynthesis. Although all cells have the potential to produce cholesterol, greater than 90% of production occurs in the liver and gut. In the biosynthesis of cholesterol, isopentyl pyrophosphate and an isomer, dimethylallyl pyrophosphate, both 5 carbon fragments, are condensed to yield geraniol CoA, a C_{10} fragment. Isopentyl pyrophosphate transferase then mediates the addition of a second isopentyl pyrophosphate moiety to geraniol CoA yielding farnesyl CoA, a C_{15} fragment. Two farnesyl molecules condense to yield squalene, a C_{30} fragment that is eventually cyclized to yield cholesterol [Voet and Voet, 1990; Stein, 1986].

2.3 Structural Classification

Citronellol, geraniol, and nerol are close structural relatives. Nerol and geraniol are *cis/trans* isomers of 3,7-dimethyl-2,6-octadien-1-ol and citronellol is the dihydro analogue of geraniol (3,7-dimethyl-6-octen-1-ol). Acetylated myrcene is a process name for the product obtained from the acetylation of the terpene hydrocarbon, myrcene. The product is predominantly (60-65%) a mixture of the acetate esters of nerol (*cis*-3,7-dimethyl-2,6-octadien-1-ol) and geraniol (*trans*-3,7-dimethyl-2,6-octadien-1-ol). The *trans* isomer, geranyl acetate (*trans*-3,7-dimethyl-2,6-octadien-1-yl acetate) is the

principal component of the mixture. Minor components include the non-esterified alcohols nerol and geraniol (2.5%) and another terpenoid ester, linalyl acetate (2.5% - also reviewed under "FFHPVC terpenoid tertiary alcohols and esters" to which reference should be made for all relevant data). The only other major component is limonene (10% - a widely naturally occurring terpene that is reviewed under "FFHPVC terpenoid aliphatic hydrocarbons – limonene group" to which reference should be made for all relevant data). No other component of this mixture exceeds 3%.

Based on their structural similarities, these substances are expected to have virtually identical physical, chemical and biological properties (see Test Plan, section 3). The available data support this conclusion. Acetylated myrcene (geranyl and neryl acetate), being the mainly a mixture of esters, is expected to be somewhat less polar and therefore less water soluble that the three terpenoid alcohols. It is however, expected to be rapidly hydrolyzed *in vivo* to yield nerol, geraniol, and acetic acid [Grundschober, 1977]. Similar hydrolysis also occurs in the environment albeit at a somewhat slower rate [AOPWIN].

Citronellol, geraniol and nerol and the principal hydrolysis products of acetylated myrcene (geranyl acetate) were all included as structural similar acyclic terpenes in a QSAR study by molecular orbital calculations for prediction of their potential toxicity/carcinogenicity [Lewis *et al*., 1994]. None of the substances in this group were predicted to have significant toxicity and/or carcinogenicity potential. This conclusion is supported by the results of a 2 year bioassay on a mixture of acetate esters of geraniol and citronellol that showed no toxic or carcinogenic effects at dose levels up to 2000 mg/kg bw/day in rats and 1000 mg/kg bw/day in mice [NTP, 1987].

2.4 Industrial and Biogenic Production

Since geraniol is used to prepare citral (a mixture of geranial and neral), an important flavor and fragrance material and an intermediate in Vitamin A synthesis, large-scale synthesis of geraniol has been developed. Production via synthesis now far exceeds isolation from essential natural oils such as citronella oil [Bauer and Garbe, 1985]. Nearly

all commercially available, technical grade geraniol is produced from pinene. In this process pinene is pyrolyzed to myrcene, which is converted into geranyl and neryl chloride. The chloride mixture is then converted to a geranyl/neryl acetate mixture, which is subsequently hydrolyzed and fractional distilled to yield geraniol (98% pure) and nerol [Weiss, 1959]. In recent years, commercially available geraniol has become available as a product of linalool isomerization. Isomerization using *ortho*-vanadate catalysts yields a 90% mixture of geraniol and nerol, which may be further purified via distillation [Yoshiaki *et al.*, 1973].

As common plant monoterpenoids, geraniol, nerol, and citronellol and their esters are ubiquitous in the environment. Accurate estimates of the environmental production of these substances is complicated by the fact that most if not all vegetation produces these alcohols and esters. However, estimates of biogenic production are critical to the determination of the sources of emission into the environment. Arguably, if background biogenic production and subsequent emission of terpenoid alcohols exceed industrial (anthropogenic) production and emission by orders of magnitude, no significant environmental impact can be expected.

Environmental monitoring has detected ambient atmospheric [Larsen *et al.*, 1997] and aquatic [Heil and Lindsay, 1990] levels of terpenoid alcohols. Trace levels of geraniol, nerol, and geranyl acetate were first detected in coniferous and deciduous plants in the early 20^{th} century (*e.g.*, eastern hemlock, spruce and Douglas fir [Guenther, 1952]). The fresh twigs and adherent leaves of Douglas fir from Washington State, Colorado, England, and Italy all show measurable levels of geraniol, nerol and geranyl acetate [Guenther, 1952].

To gain a perspective on the magnitude of annual biogenic production of terpenes including terpenoid alcohols, consider the production of geraniol by a common evergreen predominant in the Western United States. Geraniol concentration in new growth fir twigs and needles in Washington State Douglas fir has been estimated to be 0.9 kg/1000kg [Johnson and Cain, 1937]. Since new growth of twigs and needles is a

dynamic process occurring annually, the value of 0.9 kg/1000kg approximates annual production of geraniol by Douglas fir. Based on a Douglas fir canopy of 80 trees/acre, a conservative annual mass yield of 80 kg new growth/tree, and 31,000,000 acres of Douglas fir in the West, it is estimated that annual biogenic production of geraniol approaches 200,000,000 kg [Curtis, 1982, 1994]. This estimate is extremely conservative since it considers biogenic production only by Douglas fir from a single region, the Western United States: it disregards all other plant production of geraniol and biogenic production from other regions of the United States.

Based on the above conservative estimates, annual biogenic production (200,000,000 kg) of geraniol is at the very least 20 times annual industrial production (9,000,000 kg) [TSCA, 1990]. Similar estimates can be made for other members of the chemical category (see Table 1).

Table 1. Annual Industrial and Isolated Biogenic Production of Terpenoid Alcohols

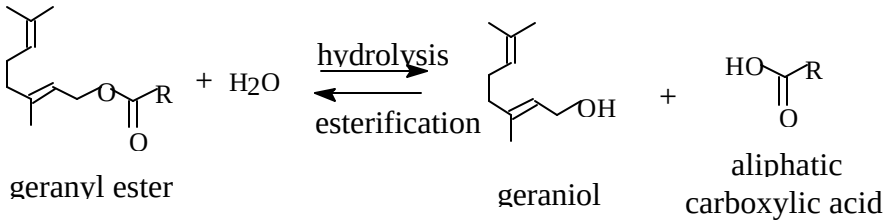
Substance	**Annual Industrial Production, kg (TSCA, 1990)**	**Annual Biogenic Production by U.S. Douglas Fir, kg**
Geraniol	9,000,000	200,000,000
Nerol	3,200,000	12,000,000
Citronellol	1,800,000	10,000,000
Acetylated Myrcene	1,000,000	8,000,000

2.5 Chemical Reactivity and Metabolism

2.5.1 Hydrolysis of Geranyl Acetate and Neryl Acetate

The ester, geranyl acetate, is expected to hydrolyze to geraniol and acetic acid (see Figure 1). In animals including fish, hydrolysis of aliphatic esters is catalyzed by classes of enzymes recognized as carboxylesterases or esterase [Heymann, 1980], the most important of which are the *B*-esterases predominating in the hepatocytes [Anders, 1989; Heymann, 1980]. A concentration of 15 ul citronellyl acetate/L was reported to be completely hydrolyzed within 2 hours by simulated intestinal fluid containing pancreatin at pH 7.5. A concentration less than 18 ul citronellyl phenylacetate/L was reported to be 60% hydrolyzed within 2 hours at pH 7.5 [Grundschober, 1977]. Terpenoid alcohols formed in the gastrointestinal tract are then rapidly absorbed [Phillips *et al.*, 1976; Diliberto *et al.*, 1988].

Figure 1. Hydrolysis of Geranyl Esters



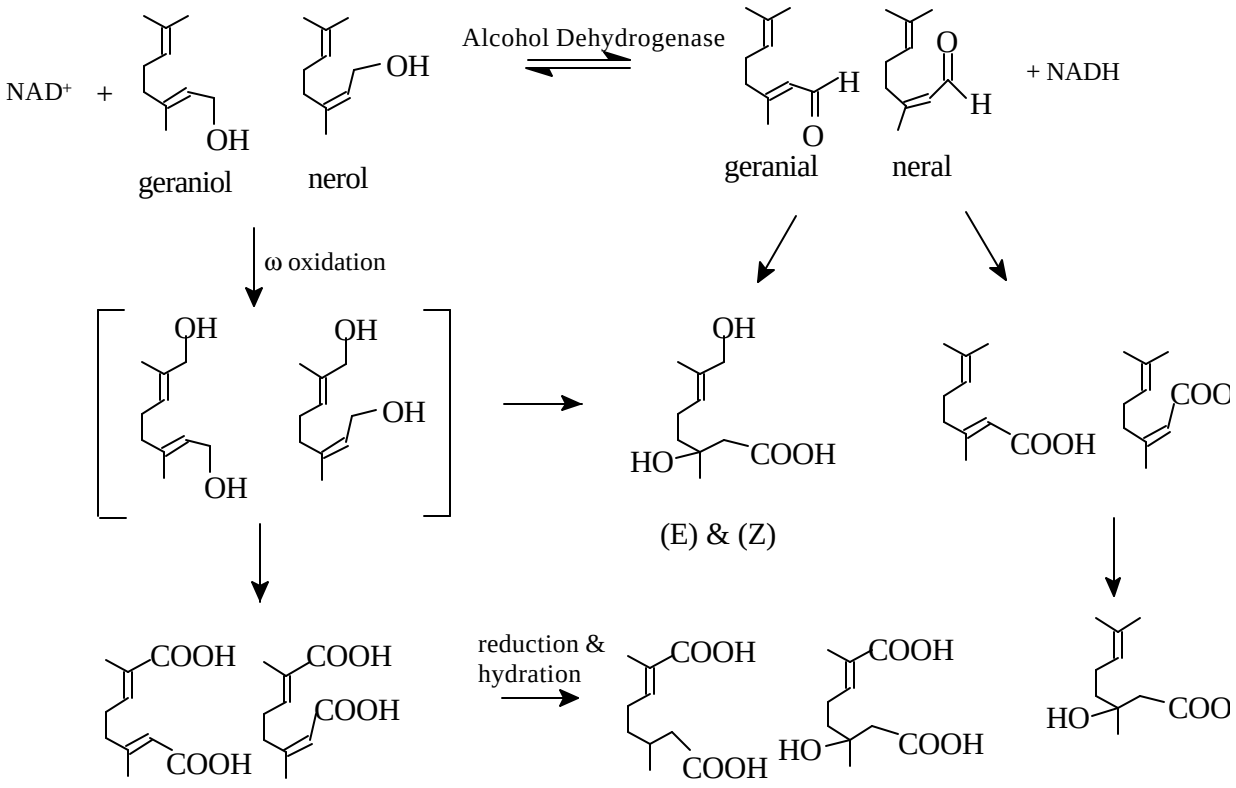
Carboxylesterase (Type B) activity has been reported in a variety of fish species at different life stages [Leinweber, 1987; Boone and Chambers, 1996; Abas and Hayton, 1997; Barron *et al.*, 1999]. Enzyme activity of rainbow trout sera, liver and whole body homogenates were similar to those of rat liver homogenate. A significant increase (300%) in activity occurred between yolk-sac and juvenile stage of rainbow trout development. Carboxylesterase activity was not significantly different for whole body homogenates of the rainbow trout, channel catfish, fathead minnows, and bluegill [Barron *et al.*, 1999].

These data support the conclusion that simple terpenoid esters including geranyl acetate are readily hydrolyzed in these animals.

2.5.2 Metabolism

Following hydrolysis, geraniol, nerol, and citronellol undergo a complex pattern of alcohol oxidation, *omega*-oxidation, hydration, selective hydrogenation and subsequent conjugation to form oxygenated polar metabolites, which are rapidly excreted primarily in the urine of animals. Alternately, the corresponding carboxylic acids formed by oxidation of the alcohol function may enter the *beta*-oxidation pathway and eventually undergo cleavage to yield shorter chain carboxylic acids that are completely metabolized to carbon dioxide [Williams, 1959]. Geraniol, related terpenoid alcohols (citronellol and nerol), and the related aldehydes (geranial and neral) exhibit similar pathways of metabolic detoxication in animals (see Figure 2).

Figure 2. Metabolism of Geraniol and Nerol in Rats



Male rats were given repeated oral doses of 800 mg [1-^{3}H]-geraniol/kg bw by gavage daily for 20 days. Five urinary metabolites were identified *via* two primary pathways. In one pathway, the alcohol is oxidized to yield geranic acid (3,7-dimethyl-2,6-octadienedioic acid) which is subsequently hydrated to yield 3,7-dimethyl-3-hydroxy-6-octenoic acid. In a second pathway, the alcohol undergoes *omega*-oxidation mediated by liver cytochrome P-450 [Chadha and Madyastha, 1982] to yield 8-hydroxygeraniol. Selective oxidation at C-8 yields 8-carboxygeraniol which undergoes further oxidation to the principal urinary metabolite 2,6-dimethyl-2,6-octadienedioic acid ("Hildebrandt's acid") [Chadha and Madyastha, 1984] (see Figure 2). In rat microsomes, the C-8 methyl group of geraniol or nerol utilizes $NADP^{+}$ and O_2 and undergoes stereoselective *omega*-hydroxylation to yield the (E)-isomer of the corresponding diol [Licht and Corsia, 1978]. In rats, the corresponding aldehyde, geranial and its (Z)-isomer, neral, are metabolized *via* similar alcohol and *omega*-oxidation pathways [Diliberto *et al.*, 1990].

Geraniol and citronellol exhibit a similar metabolic fate in rabbits. Geraniol orally administered to rabbits by gavage is metabolized to 2,6-dimethyl-2,6-octadienedioic acid ("Hildebrandt's acid") and 2,6-dimethyl-2-octendioic acid ("reduced Hildebrandt's acid"), which are excreted in the urine [Fischer and Bielig, 1940]. In rabbits, d-citronellol is also metabolized to 2,6-dimethyl-2-octendioic acid ("reduced Hildebrandt's acid") [Asano and Yamakawa, 1950]. An alcohol precursor to "reduced Hildebrandt's acid" (8-hydroxy-3,6-dimethyl-6-octenoic acid) has been reported as a urinary metabolite in rabbits given citronellol by gavage [Fischer and Bielig, 1940]. The corresponding aldehyde citronellal undergoes *omega*-oxidation mediated by liver cytochrome P-450 [Chadha and Madyastha, 1982] to yield "reduced Hildebrandt's acid" [Ishida *et al.*, 1989].

In rats and mice, a mixture of geranial and neral commonly recognized as citral undergoes rapid absorption from the gastrointestinal tract and distribution throughout the body [Phillips *et al.*, 1976]. Approximately 60% of an oral dose of $^{14}C_1$ or $^{14}C_2$-labelled

citral was eliminated in the urine with approximately equal amounts of remaining radioactivity appearing in the exhaled air and feces within 24 hours [Diliberto *et al.*, 1988]. The CO_2 arose from rapid oxidation of the aldehyde and decarboxylation of the resulting acid. Although excretion in the feces was not a primary route of elimination, a significant quantity of citral was present in the bile [Diliberto *et al.*, 1988] suggesting that citral readily enters enterohepatic circulation. This is consistent with the observations that citral induces hepatic cytochrome P-450, glucuronyl transferase and alcohol dehydrogenase [Parke and Rahman, 1969; Boyer and Petersen, 1990].

In rats, citral is metabolized to a mixture of diacids and hydroxy acids resulting from *omega*-oxidation, reduction and hydration of the unsaturation at C-2, and oxidation of the aldehyde function [Diliberto *et al.*, 1990] (Figure 1). Greater than 50% of an oral dose of citral was excreted in the urine as diacids and hydroxy acids within 24 hours. Although the only metabolites observed in the urine are those derived from oxidation of the aldehyde function, hepatic reduction of the aldehyde may precede oxidation pathways. Citral is rapidly reduced to the corresponding alcohol-by-alcohol dehydrogenase (ALD) in rat hepatic cytosolic fractions [Boyer and Petersen, 1990].

Citral is not oxidized by mitochondrial aldehyde dehydrogenase and is a potent inhibitor of ALD-mediated oxidation of acetaldehyde [Boyer and Petersen, 1990]. Since geranial and the corresponding alcohol geraniol form analogous urinary metabolites [Chadha and Madyastha, 1984], it is reasonable to assume that geranial is reduced to geraniol, which is a substrate for cytochrome P-450 mediated *omega*-oxidation.

2.6 Summary for Category Analysis

In summary, geranyl acetate is rapidly hydrolysed in animals. The alcohols geraniol, nerol, and citronellol are efficiently detoxicated by two principal pathways in animals. In one route, the alcohols are successively oxidized to the corresponding aldehydes and carboxylic acids, the latter of which are selectively hydrated or reduced. In a second route, the aldehydes undergo reduction to the corresponding alcohols that are substrates

for *omega*-oxidation to eventually yield diacids and their reduced or hydrated analogs. Polar metabolites formed *via* these two pathways will be efficiently excreted primarily in the urine as the glucuronic acid conjugates. The physiochemical and toxicological properties of these three alcohols are consistent with their known reactivity and common metabolic fate.

3 Test Plan

3.1 Chemical and Physical Properties

3.1.1 Melting Point

These are relatively low molecular weight liquids with expected melting points well below 0°C.

3.1.2 Boiling Point

While none of the reported boiling points were obtained according to OECD guidelines, the consistency of the values reported by the Fragrance Materials Association [FMA] for citronellol, geraniol and nerol (range 225 °C to 230 °C) and in standard reference sources [Merck Index, 1997] confirms their reliability. The narrow range for boiling points is consistent with the fact that the three substances are C_{10} alcohols that differ in molecular weight by 2 daltons (154 to 156 daltons) and are either *cis/trans* isomers or dihydro derivatives of one another. No boiling point is available for acetylated myrcene, however the principle components have boiling points as follows: neryl acetate – 231 °C; geranyl acetate – 244 °C [FMA]. The mixture, acetylated myrcene, would therefore be expected to boil in the same range as citronellol, geraniol and nerol.

3.1.3 Vapor Pressure

While the reported vapor pressure for citronellol, 0.0095 kPa at 30°C [Vuilleumeir *et al.*, 1995], was not obtained according to OECD guidelines, the agreement with the calculated values reported by the FMA at 20 °C (0.009 kPa for citronellol, 0.003 kPa for geraniol, and 0.008 kPa for nerol) confirm the reliability of all values. A vapor pressure of 0.009 kPa [FMA] for a mixture of the corresponding aldehydes geranial and neral is slightly greater than that for the corresponding alcohols nerol and geraniol. This is expected given the increased polarity and decreased volatility of the alcohol relative to the aldehyde. No vapor pressure is available for acetylated myrcene. However the

principle components have vapor pressures as follows: neryl acetate – 0.003 kPa; geranyl acetate – 0.004 kPa; limonene – 0.16 kPa. The components of acetylated myrcene would therefore be expected to have a vapor pressure in the same range as citronellol, geraniol and nerol.

3.1.4 Octanol/Water Partition Coefficients

The calculated log Kow values as reported by Syracuse Research Corporation [SRC], for citronellol, geraniol and nerol are very consistent and are in the range from 3.45 to 3.47. The reliability and conservative nature of these figures are confirmed by the measured log Kow of 3.1 for citronellol [Givaudan-Roure, 1991]. No octanol/water partition coefficient is available for acetylated myrcene, however, the principle components have calculated log Kow values [SRC] as follows: neryl acetate – 4.48 kPa and geranyl acetate – 4.48 kPa. Limonene has a measured log Kow of 4.57. The mixture, acetylated myrcene, would therefore be expected to have a log Kow of about 4.5. Decreased solubility of geranyl acetate compared to that for geraniol is expected given that geranyl acetate is an ester and lacks a polar alcohol functional group that increases water solubility.

3.1.5 Water Solubility

While the reported water solubilities were not obtained according to OECD guidelines, the agreement of the values reported, 600 mg/L for citronellol and 300 mg/L for geraniol, [BBA, 1990] with the calculated values [ESPOW], 211, 256 and 256 mg/L for citronellol, geraniol and nerol, respectively, support their reliability. No water solubility data are available for acetylated myrcene. However, the principle components being esters have lower solubilities than their component alcohols. The calculated water solubilities of neryl acetate and geranyl acetate are both 6.9 mg/L. The other major component, limonene has a calculated solubility of 3.1 mg/L.

3.1.6 New testing required

None

3.2 Environmental Fate and Pathways

3.2.1 Photodegradation

The calculated photodegradation half lives [AOPWIN] for citronellol, geraniol and nerol are in the range from 19 minutes to 1.3 hours. Acetylated myrcene can be expected to be in the same range since the calculated half-life for it's principal constituents, neryl acetate and geranyl acetate, is 19 minutes and for the second major constituent, limonene, is 37 minutes. Structurally, these substances are unsaturated primary alcohols that have the potential to form radical species in the gas phase and also be oxidized to the corresponding unsaturated aldehyde. The known chemical reactivity of these substrates supports short photodegradation half-lives predicted by the model.

3.2.2 Stability in Water

No hydrolysis is possible for the three terpenoid primary alcohols, citronellol, geraniol and nerol. All three are expected to be very stable in aqueous solution. The principal constituents of acetylated myrcene, geranyl acetate and neryl acetate are esters and are calculated to have half-lives for hydrolysis of 23 days at pH 8 and 231 days at pH 7 [AOPWIN]. Complete (100%) hydrolysis for citronellyl acetate was measured in simulated intestinal fluid at pH=7.5 [Grundschober, 1977]. Therefore, hydrolysis of geranyl acetate and neryl acetate is expected both *in* vivo and in the environment. The second major constituent of acetylated myrcene, limonene, will not hydrolyse in water. The significance of calculated half-life data for geranyl acetate must take into account the experimental data that aliphatic ester, in general, are readily hydrolyzed in fish [Barron *et al.*, 1999].

3.2.3 Biodegradation

Duplicate studies on citronellol and geraniol show these materials to be readily biodegradable (*i.e.,* 100% biodegradation by OECD 301B, OECD 301C, or DOC - Method F from Blue book series, 1991) [BBA, 1990; Givaudan-Roure, 1989; Quest, 1994]. Likewise, a mixture of geranial and neral (citral) exhibits greater than 92%

(OECD 301B) [Quest, 1994] and 99.5% biodegradation (DOC - Method F from Blue book series, 1991) [BBA, 1990]. Nerol is a stereoisomer of geraniol and would likewise be expected to be readily biodegradable. Geranyl acetate has also been shown to be readily biodegradable (greater than 82% biodegradation) [Birch and Fletcher, 1991] and, therefore, neryl acetate would be as well. The other significant constituent of acetylated myrcene, limonene, has not been shown to be readily biodegradable. However, since limonene makes up only 10% of the mixture, a ready biodegradation test of the mixture is expected to result in apparent ready biodegradation. In summary, all members of the chemical category are expected to readily biodegrade in the environment.

3.2.4 Fugacity

Transport and distribution in the environmental were modeled using Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11 [Mackay, 1991]. The principal input parameters into the model are molecular weight, melting point, vapor pressure, water solubility, and log Kow. Where measured values were available, these were used but where they were not, calculated data from the EPIWIN series of programs were used. Based on the comparable physiochemical properties of the three alcohols (geraniol, nerol, and citronellol), it is not unexpected that the three would exhibit similar distribution in the environment. Since acetylated myrcene (geranyl acetate) is hydrolyzed, it forms geraniol in the environment. The significance of these calculations must be evaluated in the context that the substances in this chemical category are products of plant biosynthesis and are, therefore, ubiquitous in the environment. Most have been shown to be readily and/or ultimately biodegradable, and the remainder would be expected to behave similarly in the environment. The model does not account for the influence of biogenic production on partitioning in the environment nor does it take into account biodegradation. The relevance of fugacity calculations for these substances is highly questionable.

3.2.5 New testing required

None

3.3 Ecotoxicity

3.3.1 Acute Toxicity to Fish

Only ECOSAR calculated values are available. The 96-hr LC50 for citronellol is calculated to be 10.7 mg/L while geraniol and nerol are calculated to be about an order of magnitude lower (0.57 mg/L) because these are treated by ECOSAR as vinyl alcohols even though they are not. They are 2,3-alkenols and ought to be treated, more appropriately, as neutral organics. If so, their acute toxicity should be very similar to citronellol. The LC50 for acetylated myrcene (principally geranyl acetate) can be estimated from its components. The calculated LC50 for geranyl acetate and neryl acetate is 1.4 mg/L while for limonene; the measured 96-hr LC50 in bluegill fish is 37 mg/L [Watkins *et al.*, 1985]. This latter value can be compared to the ECOSAR calculated value of 0.39 mg/L to demonstrate the conservative nature of the models. Because of the lack of data on this group, conducting an assay with geraniol should validate the QSAR algorithm for the three structurally related terpenoid primary alcohols. The results of this study can be compared to calculated 96-hr LC50 data for citronellol and calculated 96-hr LC50 data for geraniol and nerol as neutral organics. Because geranyl acetate and neryl acetate will be readily hydrolysed to nerol and geraniol, and the value for limonene is known, it is not necessary to conduct testing on acetylated myrcene.

3.3.2 Acute Toxicity to Aquatic Invertebrates

Only an ECOSAR calculated value is available for citronellol and at 12.4 mg/L (48-hr Daphnia), it does not differ significantly from that for fish. Because geraniol and nerol are treated by ECOSAR as vinyl alcohols even though they are not, there are insufficient data on structurally related substances to calculate the acute toxicity to invertebrates. They more appropriately ought to be treated as neutral organics. If so, their acute toxicity should be very similar to citronellol. The 48-hr Daphnia LC50 for acetylated myrcene can be estimated from its components. The calculated 48-hr LC50 for geranyl acetate or neryl acetate is 0.86 mg/L, while for limonene the measured 48-hr LC50 in Daphnia pulex is 37 mg/L [Passino and Smith, 1987]. As in the case of acute toxicity to fish, this latter

value can be compared to the ECOSAR calculated value of 0.50 mg/L to demonstrate the conservative nature of the models. Because of the lack of data on this group, the QSAR algorithm should be validated by conducting a test on geraniol (the same one as chosen above). It is not necessary to conduct testing on acetylated myrcene, because geranyl acetate and neryl acetate are expected to be readily hydrolysed to nerol and geraniol, and the value for limonene is known.

3.3.3 Acute Toxicity to Aquatic Plants

In addition to ECOSAR calculated EC50 values, experimental data the three terpenoid primary alcohols and citral are available. Citronellol, geraniol, nerol, and citral were subjected to a plate inhibition assay using concentrations of 100, 1000 or 10,000 mg/L [Ikawa *et al.*, 1992]. In this experiment, three disks containing the above solutions were applied to *Chlorella p*-seeded agar plates that were then placed under a fluorescent light for 48-hr. At 10,000 mg/L, each of the four substances showed a complete wipe out of the yellow-green lawn color of *Chlorella p*. At 1000 mg/L, citronellol showed no effect on growth while geraniol and nerol showed a lightening of lawn color compared to control plates. At 1000 mg/L, citral showed complete wipe out of lawn color. At 100 mg/l, geraniol, nerol, and citral show no inhibitory effect on growth. Inhibition appeared to take place through the vapor phase rather then by diffusion through the agar medium in that inhibition also occurred when the solution disks were separated from the agar surface by Teflon disks.

ECOSAR calculated 96-hr EC50 is available for citronellol and at 8.2 mg/L it does not differ significantly from the calculated values for fish or Daphnia. Because geraniol and nerol are treated by ECOSAR as vinyl alcohols even though they are not, there are insufficient data on structurally related substances to calculate the acute toxicity to algae. More appropriately, they ought to be treated as neutral organics. If so, their acute toxicity to algae should be very similar to citronellol. The algal EC50 for acetylated myrcene (geranyl acetate) can be estimated from its components. The calculated 96-hr EC50 for geranyl acetate and neryl acetate is 0.12 mg/L while for limonene it is 0.36 mg/L.

The experimental data for cited for citronellol, geraniol, nerol, and citral indicates a very low order of acute toxicity to algae. No inhibition to growth was observed at 100 mg/L for any of the four substances [Ikawa *et al.*, 1992]. These experimental NOE values are approximately two orders of magnitude greater than ECOSAR calculated EC50 values, demonstrating the conservative nature of the model. Based on these results it is not necessary to perform any further testing for this endpoint.

3.3.4 New Testing Required

- Acute toxicity to fish by OECD guideline 203 for geraniol.
- Acute toxicity to Daphnia by OECD guideline 202 for geraniol.

3.4 Human Health Data

3.4.1 Acute Toxicity

Rat oral LD50 values are available for citronellol, geraniol and nerol and are all in the same range. All indicate these materials to be very low in oral acute toxicity with values ranging from 3450 mg/kg to 6330 mg/kg [Moreno, 1972, 1973; Yamawaki, 1962; Jenner, 1964]. Rabbit dermal LD50 values are similarly very low. Values are in range from 2650 mg/kg to 5000 mg/kg [Moreno, 1972, 1973]. The mouse inhalation ED25 values are likewise low [Troy, 1977]. No data are available for acetylated myrcene; however, the LD50 values for the all of the major components are known and are all in the range of 5000 mg/kg.

3.4.2 Genotoxicity *in vitro* and *in vivo*

3.4.2.1 *In vitro*

In vitro genotoxicity assays available for citronellol, geraniol, citral (geranial and neral mixture) and acetylated myrcene (geranyl acetate and neryl acetate mixture) demonstrate that these substances have a low genotoxic potential. In standard Ames assays, various strains of *Salmonella typhimurium* were incubated with concentrations of geraniol up to and including 5000 µg/plate [Eder *et al.*, 1980; Florin *et al.*, 1980; Ishidate *et al.*, 1984;

Heck *et al.*, 1989]. No mutagenic effects were reported in any study. No evidence of mutagenicity was reported in an Ames assay with citronellol metabolites [Rockwell and Raw, 1979]. In two chromosomal aberration assays with geraniol and a geranial/neral mixture, there was no evidence of increased incidence of chromosomal aberrations when Chinese hamster lung fibroblasts were incubated with 125 µg/plate of geraniol or 30 µg/plate of the geranial/neral mixture, respectively [Ishidate *et al.*, 1984]. Nerol, being a geometrical isomer of geraniol would also be expected to be negative. The acetates of nerol and geraniol, the principal constituents of acetylated myrcene, which will hydrolyse to nerol and geraniol, have also been tested and found to be negative in Ames assays at concentrations up to 20,000 µg/plate [Mortelmans *et al.*, 1986; Heck *et al.*, 1989]. Also, there was no evidence of unscheduled DNA synthesis when 100 nl/ml of geranyl acetate was incubated with freshly prepared rat hepatocytes [Heck *et al.*, 1989]. The only other major component of acetylated myrcene is limonene, which is also negative in *in vitro* genotoxicity assays.

3.4.2.2 In vivo

In vivo tests on citronellol and acetylated myrcene (geranyl acetate) confirm the lack of genotoxic potential. A mixture of geranyl acetate (79%) and citronellyl acetate (21%) showed no evidence of increased micronuclei in a standardized mouse (B6C3F1 strain) micronucleus assay at dose levels up to and including 1800 mg/kg bw [Shelby *et al.*, 1993] and there was no evidence of unscheduled DNA synthesis when the geranyl acetate/citronellyl acetate mixture was given orally to Fisher F344 rats [Mirsalis *et al.*, 1983]. Since these esters hydrolyze to geraniol and citronellol in rodents [Grundschober, 1977; Heymann, 1980], these results apply directly to geraniol and citronellol. In an attempt to assess the mutagenicity of urinary metabolites of citronellol, an Ames assay was performed on the urine of rats given oral doses of 100 ul of citronellol. No mutagenic effects were reported [Rockwell and Raw, 1979]. Results of studies for the mixture of geranyl and citronellyl acetate and citronellol confirm that these terpenoid alcohols and related ester exhibit low genotoxic potential *in vivo*.

3.4.3 Repeat Dose Toxicity

3.4.3.1 Short-term studies

Citronellol, as an equal mixture with the structurally similar material linalool, administered to rats at 100 mg/kg/day for 12 weeks, resulted in no adverse effects [Oser, 1958]. Geraniol, in combination with a structural isomer, was administered to groups of rats (5/sex/group) in the diet at concentrations of 10,000 ppm for 16 weeks or 1000 ppm for 27 weeks. No adverse effects were reported in either study [Hagan *et al.*, 1967]. No adverse effects were reported when Osborne-Mendel rats (10/sex/group) were maintained on diets resulting in an average daily intake of 200 mg/kg bw/day for 91 days [Hagan *et al.*, 1967]. For 17 weeks, Osborne-Mendel rats (10/sex/group) were maintained on diets containing 1000, 2,500, or 10,000 ppm of geranyl acetate (acetylated myrcene). The dietary concentrations were calculated to provide average daily intakes of 50, 125, or 500 mg/kg bw. No effects were reported in the study [Hagan *et al.*, 1967]. Likewise, no adverse effects were observed when rats were maintained on a diet calculated to provide an estimated average daily intake of greater than 200 mg/kg bw/day of citral, a mixture of geranial and neral, for 91 days [Hagan *et al.*, 1967].

3.4.3.2 Long-term studies

A mixture of geranyl acetate (79%) and citronellyl acetate (21%), which would be hydrolysed to geraniol and citronellol, respectively, has been the subject of 14 day, 13-week and 103-week oral (gavage) repeat dose studies in both rats and mice conducted by the National Toxicology Program [NTP, 1987]. According to the authors, "Under conditions of the 2-year bioassay there was no evidence of carcinogenicity when male and female Fisher F344 rats were administered 2000 mg/kg bw/day of a mixture of geranyl acetate and citronellyl acetate by gavage" [NTP, 1987]. Similarly, there was no evidence of carcinogenicity when both sexes of B6C3F1 mice were administered 1000 mg/kg bw/day by gavage for 103 weeks.

3.4.4 Reproductive Toxicity

Data on reproductive toxicity is available for a mixture of geranial and neral, *trans*- and *cis*-3,7-dimethyl-2,6-octadienal, respectively. Geraniol and nerol are rapidly oxidized to form geranial and neral, respectively, *in vivo*. Given that the mixture of aldehydes exhibits a higher level of toxicity than the corresponding alcohols geraniol and nerol (see Robust Summaries for Repeat Dose and Acute Toxicity), data on reproductive and developmental toxicity for the aldehydes may be used to conservatively estimate reproductive toxicity for the corresponding alcohols.

A mixture of geranial and neral has been subjected to an oral 2-generation reproductive study in rats. There were no reproductive effects at the maternal NOAEL of 50 mg/kg/day and a fetal/pup NOAEL of 160 mg/kg bw/day. At a maternally toxic level of 500 mg/kg bw/day, the only effect reported was a slightly decreased pup weight [Hoberman *et al.*, 1989].

In a developmental/reproduction screening study, four groups of 10 virgin Crl CD female Sprague-Dawley rats were administered the acetal formed from citral (geranial and neral mixture) and ethanol. The acetal will readily hydrolyze to citral. Dose levels of 0, 125, 250, or 500 mg/kg bw/day test material was given by gavage once daily, 7 days prior to cohabitation, through cohabitation (maximum of 7 days), gestation, delivery, and a 4-day post-parturition period. The duration of the study was 39 days. Maternal indices monitored included twice-daily observation, measurement of body weights, food consumption, duration of gestation, and fertility parameters (mating and fertility index, gestation index, number of offspring per litter). Offspring indices included daily observation, clinical signs, examination for gross external malformations, and measurement of body weight. Based on these measurements the NOAELs for maternal toxicity and developmental toxicity were reported to be 125 and 250 mg/kg bw/day, respectively [Vollmuth *et al.*, 1995].

3.4.5 Developmental/Teratogenicity Toxicity

A geranial/neral mixture has been subjected to an oral feto-toxicity study and an inhalation developmental study in rats. In the feto-toxicity study, female Wistar rats were administered dose levels of 0, 60, 125, 500, and 1000 mg/kg bw of a geranial/neral mixture in corn oil daily by gavage during days 6-15 of pregnancy. A NOAEL for maternal and developmental toxicities were reported to be 60 mg/kg bw/day [Christina *et al.*, 1995]. In the inhalation developmental study, groups of female Sprague-Dawley rats were exposed to atmospheres containing up to 85 ppm of a geranial/neral mixture 6 hours daily during days 6-15 of gestation. A NOAEL for maternal toxicity was reported to be 35 ppm. There were some slight fetotoxic effects at the maternally toxic level of 85 ppm (as a vapor/aerosol) [Gaworski *et al*., 1992]. The materials in this group would not be expected to differ significantly in developmental or reproductive toxicity studies.

3.4.6 New Testing Required

None

3.5 Test Plan Table

Chemical	Physical-Chemical Properties				
	Melting Point	**Boiling Point**	**Vapor Pressure**	**Partition Coefficient**	**Water Solubility**
CAS No. 106-22-9 3,7-Dimethyl-6-octen-1-ol (dl-Citronellol)	NA	A	A	A	A, Calc
CAS No. 106-24-1 *trans*-3,7-Dimethyl-2,6-octadien-1-ol (Geraniol)	NA	A	Calc	Calc	A, Calc
CAS No. 106-25-2 *cis*-3,7-Dimethyl-2,6-octadien-1-ol (Nerol)	NA	A	Calc	Calc	Calc, R
CAS No. 68412-04-4 3,7-Dimethyl-2,6-octadien-1-yl acetate (Acetylated myrcene)	NA	A	Calc, R	Calc, R	Calc, R

Chemical	Environmental Fate and Pathways			
	Photodegradation	**Stability in Water**	**Biodegradation**	**Fugacity**
CAS No. 106-22-9 3,7-Dimethyl-6-octen-1-ol (dl-Citronellol)	Calc	NA	A	Calc
CAS No. 106-24-1 *trans*-3,7-Dimethyl-2,6-octadien-1-ol (Geraniol)	Calc	NA	A	Calc
CAS No. 106-25-2 *cis*-3,7-Dimethyl-2,6-octadien-1-ol (Nerol)	Calc	NA	R	Calc
CAS No. 68412-04-4 3,7-Dimethyl-2,6-octadien-1-yl acetate (Acetylated myrcene)	R	A, Calc	A	Calc

Chemical	Ecotoxicity		
	Acute Toxicity to Fish	**Acute Toxicity to Aquatic Invertebrates**	**Acute Toxicity to Aquatic Plants**
CAS No. 106-22-9 3,7-Dimethyl-6-octen-1-ol (dl-Citronellol)	R, Calc	Calc, R	A, Calc, R
CAS No. 106-24-1 *trans*-3,7-Dimethyl-2,6-octadien-1-ol (Geraniol)	Test, Calc	Test	A, Test
CAS No. 106-25-2 *cis*-3,7-Dimethyl-2,6-octadien-1-ol (Nerol)	Calc, R	R	A, R
CAS No. 68412-04-4 3,7-Dimethyl-2,6-octadien-1-yl acetate (Acetylated myrcene)	R	R	R

Chemical	Human Health Data					
	Acute Toxicity	**Genetic Toxicity *In Vitro***	**Genetic Toxicity *In Vivo***	**Repeat Dose Toxicity**	**Repro-ductive Toxicity**	**Develop-mental Toxicity**
CAS No. 106-22-9 3,7-Dimethyl-6-octen-1-ol (dl-Citronellol)	A	A	R	A	R	R
CAS No. 106-24-1 *trans*-3,7-Dimethyl-2,6-octadien-1-ol (Geraniol)	A	A	R	A	R	R
CAS No. 106-25-2 *cis*-3,7-Dimethyl-2,6-octadien-1-ol (Nerol)	A	R	R	R	R	R
CAS No. 68412-04-4 3,7-Dimethyl-2,6-octadien-1-yl acetate (Acetylated myrcene)	A	A	A	A	R	R

Legend

Symbol	Description
R	Endpoint requirement fulfilled using category approach, SAR
Test	Endpoint requirements to be fulfilled with testing
Calc	Endpoint requirement fulfilled based on calculated data
A	Endpoint requirement fulfilled with adequate existing data
NR	Not required per the OECD SIDS guidance
NA	Not applicable due to physical/chemical properties
O	Other

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The Flavor and Fragrance High Production Volume Consortia

Robust Summaries for Terpenoid Primary Alcohols and Related Esters

FFHPVC Terpene Consortium Registration Number

The evaluation of the quality of the following data uses a systematic approach described by Klimisch [Klimisch *et al.*, 1996]. Based on criteria relating to international testing standards for categorizing data reliability, four reliability categories have been established. The following categories are:

- Reliability code 1. Reliable without restrictions
- Reliability code 2. Reliable with restrictions
- Reliability code 3. Not reliable
- Reliability code 4. Not assignable

1 Chemical and Physical Properties

1.1 Boiling Point

Substance Name	dl-citronellol
CAS	106-22-9
GLP	NG
Year	1989
Boiling Point	225 °C
Pressure	1013 (760 mm Hg)
Pressure Unit	Millibars
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Givaudan-Roure (1989) Determination of the ready biodegradability of d,l-citronellol. Unpublished report to Fragrance Materials Association.

Substance Name	Geraniol
CAS	106-24-1
GLP	NG

Boiling Point	230 ℃
Pressure	760
Pressure Unit	mm Hg
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Fragrance Materials Association (FMA) Reported values for boiling point.

Substance Name	Nerol
CAS	106-25-2
GLP	NG
Boiling Point	225 ℃
Pressure	760
Pressure Unit	mm Hg
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Fragrance Materials Association (FMA) Reported values for boiling point.

Substance Name	Citral
CAS	5392-40-5
Remarks for Substance	Substance supported under SIDS
GLP	NG
Boiling Point	230 ℃
Pressure	760
Pressure Unit	mm Hg
Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Fragrance Materials Association (FMA) Reported values for boiling point.

Substance Name	Acetylated myrcene (data given for major component, geranyl acetate)
CAS	68412-04-4
GLP	NG
Boiling Point	244 ℃

Pressure	760
Pressure Unit	mm Hg
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Fragrance Materials Association (FMA) Reported values for boiling point.

Substance Name	Acetylated myrcene (data given for major component, neryl acetate)
CAS	68412-04-4
GLP	NG
Boiling Point	231 ℃
Pressure	760
Pressure Unit	mm Hg
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Fragrance Materials Association (FMA) Reported values for boiling point.

1.2 Vapor Pressure

Substance Name	dl-citronellol
CAS	106-22-9
Method/guideline	Measured
Year	1995
Vapor Pressure	0.0095 kPa (0.071 mm Hg)
Temperature	30 ℃
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Vuilleumier C., Flament I. And Sauvegrain P. (1995) Headspace analysis study of evaporation rate of perfume ingredients applied onto skin. International Journal of Cosmetic Science 17, 61-76.

Substance Name	Geraniol
CAS	106-24-1
Method/guideline	Calculated

Vapor Pressure	0.003 kPa (0.023 mm Hg)
Temperature	20 ℃
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Fragrance Materials Association (FMA). Reported values for vapor pressure.

Substance Name	Nerol
CAS	106-25-2
Method/guideline	Calculated
Vapor Pressure	0.008 kPa (0.060 mm Hg)
Temperature	20 ℃
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Fragrance Materials Association (FMA). Reported values for vapor pressure.

Substance Name	Citral
CAS	5392-40-5
Remarks for substance.	Substance supported under SIDS
Method/guideline	Calculated
Vapor Pressure	0.009 kPa (0.068 mm Hg)
Temperature	20 ℃
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Fragrance Materials Association (FMA). Reported values for vapor pressure.

Substance Name	Acetylated myrcene (data for principal component geranyl acetate)
CAS	68412-04-4
Remarks for substance.	Substance supported under SIDS
Method/guideline	Calculated
Vapor Pressure	0.004 kPa (0.03 mm Hg)
Temperature	25 ℃

Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Fragrance Materials Association (FMA). Reported values for vapor pressure.

Substance Name	Acetylated myrcene (data for principal component neryl acetate)
CAS	68412-04-4
Remarks for substance.	Substance supported under SIDS
Method/guideline	Calculated
Vapor Pressure	0.003 kPa (0.02 mm Hg)
Temperature	25 ℃
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Fragrance Materials Association (FMA). Reported values for vapor pressure.

1.3 Octanol/Water Partition Coefficient

Substance Name	dl-citronellol
CAS	106-22-9
Method/guideline	OECD Guideline No. 117; Reference substances = Thiourea, Acetophenone, Benzophenone, Naphthalene, 1,2,4-Trichlorobenzene
GLP	Yes
Year	1991
Remarks for Test Conditions	Reverse phase HPLC
Log Pow	3.1
Remarks for Results	Average retention time: 5.01
Conclusion Remarks	Good correlation with calculated log Pow of 3.56
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study. The log Kow compares well with the calculated value. Data are considered reliable.
References	Givaudan-Roure (1991) Partition coefficient n-octanol/water of d,l-citronellol. Private communication to FMA.

Substance Name	Geraniol

CAS	106-24-1
Method/guideline	Calculated
GLP	NG
Log Pow	3.47
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Calculated Log Kow compares well with the measured value for the very closely related citronellol. Data are considered reliable.
References	Syracuse Research Corporation (SRC). Private communication to FMA.

Substance Name	Nerol
CAS	106-25-2
Method/guideline	Calculated
Log Pow	3.47
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Calculated Log Kow compares well with the measured value for the very closely related citronellol. Data are considered reliable.
References	Syracuse Research Corporation (SRC). Private communication to FMA.

Substance Name	Citral
CAS	5392-40-5
Remarks for substance	Substance supported under SIDS.
Method/guideline	Calculated
Log Pow	3.45
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Calculated Log Kow compares well with the measured value for the very closely related citronellol. Data are considered reliable.
References	Syracuse Research Corporation (SRC). Private communication to FMA.

Substance Name	Acetylated myrcene (data for principal component neryl acetate)
CAS	68412-04-4
Method/guideline	Calculated
Log Pow	4.48
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.

Remarks for Data Reliability	Calculated Log Kow compares well with the measured value for the very closely related citronellol. Data are considered reliable.
References	Syracuse Research Corporation (SRC). Private communication to FMA.

Substance Name	Acetylated myrcene (data for principal component geranyl acetate)
CAS	68412-04-4
Method/guideline	Calculated
Log Pow	4.48
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Calculated Log Kow compares well with the measured value for the very closely related citronellol. Data are considered reliable.
References	Syracuse Research Corporation (SRC). Private communication to FMA.

1.4 Water Solubility

Substance Name	dl-Citronellol
CAS No.	106-22-9
Method/guideline	Calculated at log Kow=3.56 (ESPKOW)
Value (mg/L) at temperature	211 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Comparable to guidelines/standards.
References	ESPOW

Substance Name	Geraniol
CAS No.	106-24-1
Method/guideline	Calculated at log Kow=3.47 (ESPKOW)
Value (mg/L) at temperature	256 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Comparable to guidelines/standards.
References	ESPOW

Substance Name	Nerol
CAS No.	106-25-2
Method/guideline	Calculated at log Kow=3.47 (ESPKOW)
Value (mg/L) at temperature	256 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Comparable to guidelines/standards.
References	ESPOW

Substance Name	dl-citronellol
CAS	106-22-9
GLP	Not given
Year	1990
Value (mg/L) at temperature	0.03% w/V (300 mg/L)
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given.
References	Bush Boake Allen, Inc (BBA) (1990) Biodegradability of geraniol and d,l-citronellol. Private communication to FMA.

Substance Name	Geraniol
CAS	106-24-1
GLP	Not given
Year	1990
Value (mg/L) at temperature	0.06% w/V (600 mg/L)
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given.
References	Bush Boake Allen, Inc (BBA) (1990) Biodegradability of geraniol and d,l-citronellol Private Communication to FMA.

Substance Name	Acetylated myrcene (data for principal component geranyl acetate)
CAS	68412-04-4
Method/guideline	Calculated
Value (mg/L) at temperature	6.9 mg/L at 25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.

Remarks for Data Reliability	Comparable to guidelines/standards.
References	ESPOW

Substance Name	Acetylated myrcene (data for principal component neryl acetate)
CAS	68412-04-4
Method/guideline	Calculated
Value (mg/L) at temperature	6.9 mg/L at 25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Comparable to guidelines/standards.
References	ESPOW

2 Environmental Fate and Pathways

2.1 Photodegradation

Substance Name	dl-citronellol
CAS	106-22-9
Method/guideline	Calculation
Test Type	AOPWIN
Half life t1/2	1.3 hrs.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	AOPWIN

Substance Name	Geraniol
CAS	106-24-1
Method/guideline	Calculation
Test Type	AOPWIN
Half life t1/2	19 mins.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	AOPWIN

Substance Name	Nerol
CAS	106-25-2
Method/guideline	Calculation
Test Type	AOPWIN
Half life t1/2	19 mins.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable
References	AOPWIN

Substance Name	Citral (mixture of geranial and neral, 93:7)
CAS	5392-40-5
Method/guideline	Calculation
Test Type	AOPWIN

Halflife t1/2	0.94 hrs.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	AOPWIN

Substance Name	Acetylated myrcene (data for principal component geranyl acetate)
CAS	68412-04-4
Method/guideline	Calculation
Test Type	AOPWIN
Half life t1/2	19 mins.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	AOPWIN

Substance Name	Acetylated myrcene (data for principal component neryl acetate)
CAS	68412-04-4
Method/guideline	Calculation
Test Type	AOPWIN
Half life t1/2	19 mins.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	AOPWIN

2.2 Stability in Water

Substance Name	Acetylated myrcene (acetylated myrcene is the process name for geranyl acetate. Data is for the dihydroisomer of geranyl acetate, citronellyl acetate)
CAS No.	68412-04-4
Method/guideline	Hydrolysis in simulated intestinal fluid (Longland, 1977)

Test Type	Ester hydrolysis in simulated intestinal fluid
Year	1977
Duration (days)	2 hours
Analytical procedures	Citronellyl acetate (15 uL/L) was incubated with pancreatin at a pH=7.5 in 0.5 M phosphate buffer at 37 C for 2 hours. The extent of hydrolysis was measured by gas-liquid chromatography.
Temperature	37 °C
Nominal	15 uL/L
Degradation %	100% hydrolysis
Halflife t1/2	<1 hour
Breakdown products	Citronellol and acetic acid
Conclusion remarks	Citronellyl acetate was completely hydrolyzed in 2 hrs at pH7.5.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Data on citronellyl ester consistent with data for 24 other aliphatic and aromatic esters.
References	Grundschober F. (1977) Toxicological assessment of flavouring esters. Toxicology, 8:387-390.

Substance Name	Acetylated myrcene (acetylated myrcene is the process name for geranyl acetate. Data is for the dihydroisomer of geranyl acetate, citronellyl phenylacetate)
CAS No.	68412-04-4
Method/guideline	Hydrolysis in simulated intestinal fluid (Longland, 1977)
Test Type	Ester hydrolysis in simulated intestinal fluid
Year	1977
Duration (days)	2 hours
Analytical procedures	Citronellyl phenylacetate (<18 uL/L) was incubated with pancreatin at a pH=7.5 in 0.5 M phosphate buffer at 37 C for 2 hours. The extent of hydrolysis was measured by gas-liquid chromatography.
Temperature	37 °C
Nominal	<18 uL/L
Degradation %	60% hydrolysis in 2 hrs.
Halflife t1/2	<2 hours
Breakdown products	Citronellol and phenylacetic acid

Conclusion remarks	Citronellyl phenylacetate was completely hydrolyzed in 2 hours at pH 7.5.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Data on citronellyl ester consistent with data for 24 other aliphatic and aromatic esters.
References	Grundschober F. (1977) Toxicological assessment of flavouring esters. Toxicology 8:387-390.

Substance Name	Acetylated myrcene (acetylated myrcene is the process name for a mixture containing mainly nerol and geranyl acetate. Data is for geranyl acetate)
CAS No.	68412-04-4
Method/guideline	Calculation
Test Type	Base/Acid-Catalyzed Hydrolysis
Temperature	25 °C
Degradation %	100% hydrolysis
Halflife t1/2	23.14 days at pH=8: 231.4 days at pH=7
Breakdown products	Geraniol and acetic acid
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	AOPWIN

2.3 Biodegradation

Substance Name	dl-citronellol
CAS	106-22-9
Remarks for Substance	96.1% citronellol
Method	OECD 301 C
Test Type	Modified MITI
GLP	No
Year	1987
Contact time (units)	28 days
Innoculum	Activated sludge from 2 sewage treatment plants mixed with soil from bank of Rhone river.

Remarks for Test Conditions	108 mg/l at 20 °C for 28 days
Degradation % after time	65% at 28 days
Time required for 10% degradation	9 days
10 day window criteria	Yes
Total degradation	No
Conclusion remarks	Readily biodegradable
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study.
References	Givaudan-Roure (1989) Determination of the ready biodegradability of d,l-citronellol. Unpublished report to FMA.

Substance Name	dl-citronellol
CAS	106-22-9
Remarks for Substance	96% mixture of *d,l*-citronellol
Method	Method F
Test Type	DOC - Method F from Blue book series, 1991
GLP	Yes
Year	1990
Contact time (units)	28 days
Innoculum	Activated sludge from local STP
Remarks for Test Conditions	41.6 mg DOC/l at 20 °C for 28 days
Degradation % after time	100% at 15 days
Results	100 % biodegradation after 15 days.
Time required for 10% degradation	< 1 day
10 day window criteria	Yes
Total degradation	Yes
Conclusion remarks	Readily biodegradable
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study.
References	Bush Boake Allen, Inc (BBA) (1990) Biodegradability of geraniol and d,l-citronellol Private communication to FMA.

Substance Name	Geraniol
CAS	106-24-1

Remarks for Substance	Mixture of geraniol (50%), nerol (26%) and citronellol (18%)
Method	OECD 301B
Test Type	CO2 evolution
GLP	Yes
Year	1994
Contact time (units)	28 days
Innoculum	Secondary effluent from sludge from local STP
Remarks for Test Conditions	10 mg/l organic carbon at 20 °C for 28 days
Degradation % after time	100% at 28 days
Time required for 10% degradation	<7 days
10 day window criteria	Yes
Total degradation	Yes
Conclusion remarks	Readily biodegradable
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study.
References	Quest International Ltd. (1994) The ultimate biodegradability of citronellol in the sealed vessel test. Private communication to FMA.

Substance Name	Geraniol
CAS	106-24-1
Remarks for Substance	99% mixture of geraniol (>70%) and nerol (<30%). EOA specification 16.
Method	Method F
Test Type	DOC - Method F from Blue book series, 1991
GLP	No
Year	1990
Contact time (units)	28 days
Innoculum	Activated sludge from local STP
Remarks for Test Conditions	42.0 mg DOC/l at 20 °C for 28 days
Degradation % after time	100% at 15 days
Time required for 10% degradation	< 1 day
10 day window criteria	Yes
Total degradation	Yes

Conclusion remarks	Readily biodegradable
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study.
References	Bush Boake Allen, Inc (BBA) (1990) Biodegradability of geraniol and d,l-citronellol. Private communication to FMA.

Substance Name	Citral
CAS	5392-40-5
Remarks for Substance	94% pure - 44% *cis* (neral) and 50% *trans* (geranial)
Method	OECD 301B
Test Type	CO2 evolution
GLP	No
Year	1994
Contact time (units)	28 days
Innoculum	Secondary effluent from sludge from local STP
Remarks for Test Conditions	10 mg/l organic carbon at 20 °C for 28 days
Degradation % after time	92.1% at 28 days
Time required for 10% degradation	< 4 days
10 day window criteria	Yes
Total degradation	Yes
Classification	Not given
Breakdown products (transient or stable?)	Not given
Conclusion remarks	Readily biodegradable
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study.
References	Quest International Ltd. (1994) The ultimate biodegradability of citronellol in the sealed vessel test. Private communication to FMA.

Substance Name	Citral
CAS	5392-40-5
Method	Method F
Test Type	DOC - Method F from Blue book series, 1991
GLP	No

Year	1990
Contact time (units)	28 days
Innoculum	Activated sludge from local STP
Remarks for Test Conditions	40.3 mg DOC/l at 20 °C for 28 days
Degradation % after time	99.5% at 19 days
Kinetic	Not given
Time required for 10% degradation	< 1 day
10 day window criteria	Yes
Total degradation	Yes
Classification	Not given
Breakdown products (transient or stable?)	Not given
Conclusion remarks	Readily biodegradable
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study
References	Bush Boake Allen, Inc (BBA) (1990) Biodegradability of geraniol and d,l-citronellol. Private communication to FMA.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	Acetylated myrcene is a mixture that is primarily (62%) acetate esters of nerol and geraniol.
Method	OECD 301B
Test Type	CO2 evolution
GLP	Not given
Year	1991
Contact time (units)	28 days
Innoculum	Secondary effluent from sludge from local STP
Remarks for Test Conditions	10 mg/l organic carbon at 20 °C for 28 days
Degradation % after time	82.2% at 28 days
Results	The requirements for ready and ultimate biodegradability were met.
Kinetic	Not given
Time required for 10% degradation	< 4 days

10 day window criteria	Yes
Total degradation	Yes
Classification	Not given
Breakdown products (transient or stable?)	Not given
Conclusion remarks	Readily biodegradable
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study.
References	Birch R. R. and Fletcher R. J. (1991) The application of dissolved inorganic carbon measurements to the study of aerobic biodegradability. Chemosphere 23(4), 507-524.

2.4 Fugacity

Substance Name	dl-citronellol
CAS	106-22-9
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Soil
Estimated Distribution and Media Concentration	42.1%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, Fl.

Substance Name	dl-citronellol
CAS	106-22-9
Model Conditions	20 ℃

Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Air-Water Partition Coefficient
Absorption coefficient	0.001
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	dl-citronellol
CAS	106-22-9
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Fish
Estimated Distribution and Media Concentration	0.0024%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	dl-citronellol
CAS	106-22-9
Model Conditions	20 ℃

Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Sediment
Estimated Distribution and Media Concentration	0.94%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	dl-citronellol
CAS	106-22-9
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Aerosol
Estimated Distribution and Media Concentration	0.00024%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	dl-citronellol
CAS	106-22-9

Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Water
Estimated Distribution and Media Concentration	37.8%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	dl-citronellol
CAS	106-22-9
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Air
Estimated Distribution and Media Concentration	19.2%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	dl-citronellol
CAS	106-22-9

Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	632000
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
Reference	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	dl-citronellol
CAS	106-22-9
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Fish-Water Partition Coefficient
Absorption coefficient	62.9
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	dl-citronellol
CAS	106-22-9
Model Conditions	20 ℃

Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	155
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	dl-citronellol
CAS	106-22-9
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Sediment-Water Partition Coefficient
Absorption coefficient	49.6
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	dl-citronellol
CAS	106-22-9
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Soil-Water Partition Coefficient
Absorption coefficient	24.8
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	dl-citronellol
CAS	106-22-9
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, log Kow, estimated MP, water solubility
Year	1999
Media	Suspended Sediment
Estimated Distribution and Media Concentration	0.029%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Air
Estimated Distribution and Media Concentration	7.93%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP,
Year	1999
Media	Suspended Sediment
Estimated Distribution and Media Concentration	0.045%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1
Model Conditions	20 ℃

Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP,
Year	1999
Media	Sediment
Estimated Distribution and Media Concentration	1.46%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Soil
Estimated Distribution and Media Concentration	65.50%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1

Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Water
Estimated Distribution and Media Concentration	25.06%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	2000000
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1

Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Fish-Water Partition Coefficient
Absorption coefficient	148
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	363
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1
Model Conditions	20 ℃

Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Sediment-Water Partition Coefficient
Absorption coefficient	116.2
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Fish
Estimated Distribution and Media Concentration	0.0037%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1
Model Conditions	20 ℃

Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Air-Water Partition Coefficient
Absorption coefficient	0.00063
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Aerosol
Estimated Distribution and Media Concentration	0.00032%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Geraniol
CAS	106-24-1
Model Conditions	20 ℃

Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Soil-Water Partition Coefficient
Absorption coefficient	58.1
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Soil
Estimated Distribution and Media Concentration	65.50%
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restrictions because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Air-Water Partition Coefficient
Absorption coefficient	0.00063
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Fish
Estimated Distribution and Media Concentration	0.0037%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Model Conditions	20 C
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Sediment
Estimated Distribution and Media Concentration	1.46%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Aerosol
Estimated Distribution and Media Concentration	0.00032%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Water
Estimated Distribution and Media Concentration	25.06%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
Reference	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Air
Estimated Distribution and Media Concentration	7.93%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	2000000
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Fish-Water Partition Coefficient
Absorption coefficient	148
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	363
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Remarks for Substance	
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Sediment-Water Partition Coefficient
Absorption coefficient	116.2
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Remarks for Test Conditions	
Media	Soil-Water Partition Coefficient
Absorption coefficient	58.1
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Nerol
CAS	106-25-2
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	MW, VP, water solubility, estimated log Kow & MP
Year	1999
Media	Suspended Sediment
Estimated Distribution and Media Concentration	0.045%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	All data estimated based on the properties of the principal components

Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility
Year	1999
Media	Air
Estimated Distribution and Media Concentration	57.6%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	All data estimated based on the properties of the principal components
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility
Year	1999
Media	Fish
Estimated Distribution and Media Concentration	0.0023%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	All data estimated based on the properties of the principal components
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility
Year	1999
Media	Suspended Sediment
Estimated Distribution and Media Concentration	0.028%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	All data estimated based on the properties of the principal components
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used (title, version, ate)	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility
Year	1999
Remarks for Test Conditions	
Media	Sediment
Estimated Distribution and Media Concentration	0.89%

Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	All data estimated based on the properties of the principal components
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility
Year	1999
Media	Soil
Estimated Distribution and Media Concentration	40.1%
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered Reliability code 2. Reliable with restrictions. because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	All data estimated based on the properties of the principal components
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility

Year	1999
Media	Water
Estimated Distribution and Media Concentration	1.43%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	All data estimated based on the properties of the principal components
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility
Year	1999
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	1200000
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Acetylated myrcene
CAS	6412-04-4
Remarks for Substance	All data estimated based on the properties of the principal components
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility
Year	1999
Remarks for Test Conditions	
Media	Fish-Water Partition Coefficient
Absorption coefficient	1580
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	All data estimated based on the properties of the principal components
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility
Year	1999
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	3890
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Acetylated myrcene
CAS	68412-04-4

Remarks for Substance	All data estimated based on the properties of the principal components
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility
Year	1999
Media	Sediment-Water Partition Coefficient
Absorption coefficient	1240
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	All data estimated based on the properties of the principal components
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility
Year	1999
Media	Air-Water Partition Coefficient
Absorption coefficient	0.080
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	All data estimated based on the properties of the principal components
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility
Year	1999
Media	Aerosol
Estimated Distribution and Media Concentration	0.0014%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	All data estimated based on the properties of the principal components
Model Conditions	20 ℃
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input parameters	Estimated MW, VP, log Kow, MP & water solubility
Year	1999
Media	Soil-Water Partition Coefficient
Absorption coefficient	622
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, D. (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

3 Ecotoxicity

3.1 Acute Toxicity to Fish

Substance Name	dl-citronellol
CAS	106-22-9
Method/guideline	ECOSAR
Test Type	Calculated based on measured Kow
Species/Strain/Supplier	Fish
Exposure period (unit)	96 hr
Conclusion remarks	LC50 = 10.7 mg/l
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	ECOSAR

Substance Name	Geraniol
CAS	106-24-1
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure period (unit)	96 hr
Conclusion remarks	LC50 = 0.57 mg/l (see Remarks for Reliability)
Remarks for Data Reliability	The data were obtained by a recognized SAR calculation method but are not consistent with chemical structure. Data are considered overly conservative by submitters.
References	ECOSAR

Substance Name	Nerol
CAS	106-25-2
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure period (unit)	96 hr
Conclusion remarks	LC50 = 0.57 mg/l (see Remarks for Reliability)
Remarks for Data Reliability	The data were obtained by a recognized SAR calculation method but are not consistent with chemical structure. Data

	are considered overly conservative by the submitters.
References	ECOSAR

Substance Name	Citral
CAS	5392-40-5
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure period (unit)	96 hr
Conclusion remarks	LC50 = 4.5 mg/l
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method but are not consistent with chemical structure. Data are considered overly conservative by the submitters.
References	ECOSAR

Substance Name	Acetylated myrcene (data given for major component, geranyl acetate)
CAS	68412-04-4
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure period (unit)	96 hr
Conclusion remarks	LC50 = 1.4 mg/l
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method but are not consistent with chemical structure. Data are considered overly conservative by the submitters.
References	ECOSAR

Substance Name	Acetylated myrcene (data given for major component, neryl acetate)
CAS	68412-04-4
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure period (unit)	96 hr
Conclusion remarks	LC50 = 1.4 mg/l
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method

	but are not consistent with chemical structure. Data are considered overly conservative by the submitters.
References	ECOSAR

3.2 Acute Toxicity to Aquatic Invertebrates

Substance Name	dl-citronellol
CAS	106-22-9
Method/guideline	ECOSAR
Test Type	Calculated based on measured Kow
Analytical procedures	Daphnia
Test details	48 hrs
EC50, EL50, LC50, at 24,48 hours	LC50=12.4 mg/l
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	ECOSAR

Substance Name	Citral
CAS	5392-40-5
Remarks for Substance	Substance supported under SIDS.
Method/guideline	ECOSAR
Test Type	Calculated
Analytical procedures	Daphnia
Test details	48 hrs
EC50, EL50, LC0, at 24,48 hours	LC50=1.1 mg/l
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	ECOSAR

Substance Name	Acetylated myrcene (data given for major component, neryl acetate)
CAS	68412-04-4
Method/guideline	ECOSAR
Test Type	Calculated

Analytical procedures	Daphnia
Test details	48 hrs
EC50, EL50, LC0, at 24,48 hours	LC50=0.86 mg/l
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	ECOSAR

Substance Name	Acetylated myrcene (data given for major component, geranyl acetate)
CAS	68412-04-4
Method/guideline	ECOSAR
Test Type	Calculated
Analytical procedures	Daphnia
Test details	48 hrs
EC50, EL50, LC0, at 24,48 hours	LC50=0.86 mg/l
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	ECOSAR

3.3 Acute Toxicity To Aquatic Plants

Substance Name	dl-citronellol
CAS	106-22-9
Method/guideline	Plate Inhibition Assay [Ikawa, 1992]
Test Type	Algal Growth Inhibition Test
Species/Strain/Supplier	Green algae
Exposure period (duration)	48 hr
Analytical Monitoring	Net diameter of inhibition zone= total diameter-disk diameter (5mm)
Remarks for Test Conditions	Three disks containing the test solution were placed on a agar plate containing Chlorella p. and then exposed to fluorescent lights for 48 hours. Zone of inhibition measured on two separate occasions.
Nominal Concentration as mg/L:	100, 1000, or 10,000 mg/L

Unit	mg/L
NOEC, LOEC	NOEC=100 or 1000 mg/L, LOEC=10,000 mg/L
Biological Observations	Complete wipe out of yellow green algal lawn at 10,000 mg/L
Statistical Evaluations?	None
Control Response Satisfactory	Yes
Conclusion remarks	No effects on growth of Chlorella p. at 1000 mg/L. Authors noted that inhibition was also observed when solution disks at concentrations of 10,000 mg/L were separated from agar medium by Teflon disks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Data was reported in a peer-reviewed journal- Journal of Chemical Ecology
References	Ikawa M., Mosley S., and Barbero L. (1992) Inhibitory effects of terpene alcohols and aldehydes on growth of green alga Chlorella pyrenoidosa. *Journal of Chemical Ecology* **18**(10),1755-1760.

Substance Name	Geraniol
CAS	106-24-1
Method/guideline	Plate Inhibition Assay [Ikawa, 1992]
Test Type	Algal Growth Inhibition Test
Species/Strain/Supplier	Green algae
Exposure period (duration)	48 hr
Analytical Monitoring	Net diameter of inhibition zone= total diameter-disk diameter (5mm)
Remarks for Test Conditions	Three disks containing the test solution were placed on an agar plate containing Chlorella p. and then exposed to fluorescent lights for 48 hours. Zone of inhibition measured on two separate occasions.
Nominal Concentration as mg/L:	100, 1000, or 10,000 mg/L
Unit	mg/L
NOEC, LOEC	NOEC=100 mg/L, LOEC=1000 mg/L
Biological Observations	Lightening of lawn color at 1000 mg/L. Complete wipe out of yellow green algal lawn at 10,000 mg/L
Statistical Evaluations?	None
Control Response Satisfactory	Yes

Conclusion remarks	No effects on growth of Chlorella p. at 100 mg/L. Authors noted that inhibition was also observed when solution disks at concentrations of 1000 or 10,000 mg/L were separated from agar medium by Teflon disks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Data was reported in a peer-reviewed journal- Journal of Chemical Ecology
References	Ikawa M., Mosley S., and Barbero L. (1992) Inhibitory effects of terpene alcohols and aldehydes on growth of green alga Chlorella pyrenoidosa. *Journal of Chemical Ecology* **18**(10),1755-1760.

Substance Name	Nerol
CAS	106-25-2
Method/guideline	Plate Inhibition Assay [Ikawa, 1992]
Test Type	Algal Growth Inhibition Test
Species/Strain/Supplier	Green algae
Exposure period (duration)	48 hr
Analytical Monitoring	Net diameter of inhibition zone= total diameter-disk diameter (5mm)
Remarks for Test Conditions	Three disks containing the test solution were placed on a agar plate containing Chlorella p. and then exposed to fluorescent lights for 48 hours. Zone of inhibition measured on two separate occasions.
Nominal Concentration as mg/L:	100, 1000, or 10,000 mg/L
Unit	mg/L
NOEC, LOEC	NOEC=100 mg/L, LOEC=1000 mg/L
Biological Observations	Lightening of lawn color at 1000 mg/L. Complete wipe out of yellow green algal lawn at 10,000 mg/L
Statistical Evaluations?	None
Control Response Satisfactory	Yes
Conclusion remarks	No effects on growth of Chlorella p. at 100 mg/L. Authors noted that inhibition was also observed when solution disks at concentrations of 1000 or 10,000 mg/L were separated from agar medium by Teflon disks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Data was reported in a peer-reviewed journal- Journal of Chemical Ecology

References	Ikawa M., Mosley S., and Barbero L. (1992) Inhibitory effects of terpene alcohols and aldehydes on growth of green alga Chlorella pyrenoidosa. *Journal of Chemical Ecology* **18**(10),1755-1760.

Substance Name	Citral
CAS	5392-40-5
Method/guideline	Plate Inhibition Assay [Ikawa, 1992]
Test Type	Algal Growth Inhibition Test
Species/Strain/Supplier	Green algae
Exposure period (duration)	48 hr
Analytical Monitoring	Net diameter of inhibition zone= total diameter-disk diameter (5mm)
Remarks for Test Conditions	Three disks containing the test solution were placed on a agar plate containing Chlorella p. and then exposed to fluorescent lights for 48 hours. Zone of inhibition measured on two separate occasions.
Nominal Concentration as mg/L:	100, 1000, or 10,000 mg/L
Unit	mg/L
NOEC, LOEC	NOEC=100 mg/L, LOEC=1000 mg/L
Biological Observations	Complete wipe out of yellow green algal lawn at 1000 and10,000 mg/L
Statistical Evaluations?	None
Control Response Satisfactory	Yes
Conclusion remarks	No effects on growth of Chlorella p. at 100 mg/L. Authors noted that inhibition was also observed when solution disks at concentrations of 1000 or 10,000 mg/L were separated from agar medium by Teflon disks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Data was reported in a peer-reviewed journal.
References	Ikawa M., Mosley S., and Barbero L. (1992) Inhibitory effects of terpene alcohols and aldehydes on growth of green alga Chlorella pyrenoidosa. *J. of Chem.l Ecology* **18**(10),1755-1760.

Substance Name	dl-citronellol
CAS	106-22-9
Method/guideline	Calculated

Test Type	ECOSAR
Species/Strain/Supplier	Green algae
Exposure period (duration)	96 hr
Conclusion remarks	EC50 = 8.2 mg/l
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	ECOSAR

Substance Name	Citral
CAS	5392-40-5
Remarks for Substance	Substance supported under SIDS.
Method/guideline	Calculated
Test Type	ECOSAR
Species/Strain/Supplier	Green algae
Exposure period (duration)	96 hr
Conclusion remarks	EC50 = 3.9 mg/l
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	ECOSAR

Substance Name	Acetylated myrcene (data given for major component, neryl acetate)
CAS	68412-04-4
Method/guideline	Calculated
Test Type	ECOSAR
Species/Strain/Supplier	Green algae
Exposure period (duration)	96 hr
Conclusion remarks	EC50 = 0.12 mg/l
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	ECOSAR

Substance Name	Acetylated myrcene (data given for major component, geranyl acetate)

CAS	68412-04-4
Method/guideline	Calculated
Test Type	ECOSAR
Species/Strain/Supplier	Green algae
Exposure period (duration)	96 hr
Conclusion remarks	EC50 = 0.12 mg/l
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation method and are consistent with chemical structure. Data are considered reliable.
References	ECOSAR

4 Human Health Data

4.1 Acute Toxicity

Substance Name	dl-citronellol
CAS	106-22-9
Remarks for Substance	Purity undetermined.
Method/guideline	NG
Test Type	Acute ED25
GLP	Not reported
Year	1977
Species/Strain	Mouse/CD-1
Sex	Female
# of animals per sex per dose	5
Vehicle	None
Route of administration	Inhalation
Remarks for test conditions	The respiratory irritation potential of fragrance raw materials was assessed in CD-1 females by recording respiratory rate using a whole body plethysmograph. Mice, weighing between 23-28 grams were exposed to test materials for 1 minute using a nebulizer for aerosolization in a 2600 ml chamber. Materials shown to be sensory irritants were further tested in mice cannulated via the trachea & compared to an intact mouse breathing through its nose. Comparisons made were between the pre-exposure & exposure rate values for each material at each dose level. Materials were of undetermined purity.
Value LD50 or LC50 with confidence limits	ED25=990 micrograms/L
Remarks for results	Slight respiratory depression. Lower tract exposures not performed
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Troy, W.R. (1977) Doctoral Dissertation: The comparative respiratory irritation potential of fourteen fragrance raw materials. Unpublished report to RIFM.

Substance Name	dl-citronellol
CAS	106-22-9
Remarks for Substance	Not reported

Method/guideline	NG
Test Type	Acute dermal LD50
GLP	Not reported
Year	1973
Species/Strain	Rabbits/New Zealand White
Sex	Not reported
# of animals per sex per dose	5
Vehicle	None
Route of administration	Dermal
Remarks for test conditions	Five rabbits per dose were administered 0, 1.25, 2.5 or 5.0 g/kg bw citronellol. Animals were observed for toxic signs and death.
Value LD50 or LC50 with confidence limits	2.65 g/kg (95% C.L. 1.78-3.52 g/kg)
Number of deaths at each dose level	1.25 g/kg 0/5 deaths; 2.5 g/kg 2/5 deaths; 5 g/kg 5/5 deaths
Remarks for results	The LD50 was calculated to be 2.65 g/kg calculated LD50, 95% limits=1.78-3.52 gm/kg. Toxic signs were ataxia and papillary dilation.
Conclusion remarks	The LD50 was reported to be 2.65 g/kg bw (2650 mg/kg bw)
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Moreno O. M. (1973) Acute oral toxicity studies on rats and rabbits. Unpublished report to RIFM.

Substance Name	dl-citronellol
CAS	106-22-9
Remarks for Substance	Not reported
Method/guideline	NG
Test Type	Oral LD50
GLP	Not reported
Year	1973
Species/Strain	Rat
Sex	Not reported
# of animals per sex per dose	10
Vehicle	None reported

Route of administration	Oral
Remarks for test conditions	Ten rats per dose level were administered 2050. 2560, 3200, 4000, or 5000 mg/kg bw citronellol and observed for fourteen days.
Value LD50 or LC50 with confidence limits	3450 mg/kg bw (95% C.L. 3210-3690 mg/kg bw)
Number of deaths at each dose level	2050 mg/kg 1/10 deaths; 2560 mg/kg 0/10 deaths; 3200 mg/kg 7/10 deaths; 4000 mg/kg 6/10 deaths; 5000 mg/kg 8/10 deaths
Remarks for results	Spontaneous activity reduced 20 min after administration. 2000 mg/kg bw spontaneous activity reduced. All animals affected 10-30 min after administration, peaked at 4-6 hr & returned to normal at 48 hr.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Moreno O. M. (1973) Acute oral toxicity studies on rats and rabbits. Unpublished report to RIFM.

Substance Name	Geraniol
CAS	106-24-1
Remarks for Substance	Purity undetermined
Method/guideline	Not given
Test Type	Acute ED25
GLP	Not reported
Year	1977
Species/Strain	Mouse/CD-1
Sex	Female
# of animals per sex per dose	5
Vehicle	None
Route of administration	Inhalation
Remarks for test conditions	The respiratory irritation potential of fragrance raw materials was assessed in CD-1 females by recording respiratory rate using a whole body plethysmograph. Mice were exposed to test materials for 1 min using a nebulizer for aerosolization in a 2600 ml chamber. Materials shown to be sensory irritants were further tested in mice cannulated via the trachea & compared to an intact mouse breathing through its nose. Comparisons made were between the pre-exposure & exposure rate values for each material at each dose level. Materials were of undetermined purity.
Value LD50 or LC50 with	ED25=570 micrograms/L

confidence limits	
Remarks for results	Mild moderate respiratory depression. No effects when inhaled through tracheal cannula.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Troy W.R. (1977) Doctoral Dissertation: The comparative respiratory irritation potential of fourteen fragrance raw materials. Unpublished report to RIFM.

Substance Name	Geraniol
CAS	106-24-1
Remarks for Substance	Not reported
Method/guideline	Litchfield-Wilcoxon, 1949 (FDA study)
Test Type	Oral LD50
GLP	Not reported
Year	1964
Species/Strain	Rat/Osborne-Mendel
Sex	Male and Female
# of animals per sex per dose	5
Vehicle	None
Route of administration	Intubation
Remarks for test conditions	5 male and 5 female young adult Osborne-Mendel rats were fasted for 18 hrs prior to treatment. Animals were observed for toxic signs and death. The observation period was 2 wks.
Value LD50 or LC50 with confidence limits	3600 mg/kg bw (95% C.L. 2840-4570)
Number of deaths at each dose level	Not reported
Remarks for results	Slope function: 1.7 (95% C.L. 1.3-2.2). Toxic signs were depression, coma, and wet fur. Times of deaths were between 4-18 hours.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study
References	Jenner P.M., Hagan E.C., Taylor J.M., Cook E.L., Fitzhugh O.G. (1964) Food flavorings and compounds of related structure I. Acute Oral Toxicity. Fd. Cosmet. Toxicol. 2, 327-343.

Substance Name	Geraniol

CAS	106-24-1
Remarks for Substance	Not reported
Method/guideline	Litchfield and Wilcoxon, 1949
Test Type	Oral LD50
GLP	Not reported
Year	1962
Species/Strain	Mixed strains rat
Sex	Not reported
Vehicle	Propylene glycol
Route of administration	Gavage
Remarks for test conditions	Groups of 8 mixed breed rats weighing approximately 150 g were given geraniol at the following doses, 1, 5, 10, 100, 1000, 2000, 5000 mg/kg bw in propylene glycol by stomach tube & observed for 48 hr. A vehicle control was also administered.
Value LD50 or LC50 with confidence limits	4800 mg/kg bw (95% C.I. 2900-5900 mg/kg bw)
Number of deaths at each dose level	5000 mg/kg bw 3/5 deaths
Remarks for results	The LD50 reported was 4800 mg/kg bw.
Conclusion remarks	The LD50 reported was 4800 mg/kg bw.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Yamawaki T. (1962). Pharmacological effects of geraniol. Nippon Yakurigaku Zasshi, 58, 394-400.

Substance Name	Nerol
CAS	106-25-2
Remarks for Substance	Purity undetermined.
Method/guideline	NG
Test Type	Acute ED25
GLP	Not reported
Year	1977
Species/Strain	Mouse/CD-1
Sex	Female
# of animals per sex per dose	5
Vehicle	None

Route of administration	Inhalation
Remarks for test conditions	The respiratory irritation potential of fragrance raw materials was assessed in CD-1 females by recording respiratory rate using a whole body plethysmograph. Mice were exposed to test materials for 1 min using a nebulizer for aerosolization in a 2600 ml chamber. Materials shown to be sensory irritants were further tested in mice cannulated via the trachea & compared to an intact mouse breathing through its nose. Comparisons were between the preexposure & exposure rate values for each material at each dose level. Materials were of undetermined purity.
Value LD50 or LC50 with confidence limits	ED25=590 micrograms/L
Remarks for results	Mild moderate respiratory depression. Lower tract exposures not performed.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Troy W.R. (1977) Doctoral Dissertation: The comparative respiratory irritation potential of fourteen fragrance raw materials. Unpublished report to RIFM.

Substance Name	Nerol
CAS	106-25-2
Remarks for Substance	Not reported
Method/guideline	NG
Test Type	Acute dermal LD50
GLP	Not reported
Year	1972
Species/Strain	Rabbit/New Zealand White
Sex	Not reported
# of animals per sex per dose	10
Vehicle	None
Route of administration	Dermal
Remarks for test conditions	A single 24 hr application was made to the clipped abraded abdominal skin of ten rabbits weighing 1.9 to 2.2 kg. Observations were made for mortality and toxic effects for a period of seven days. Gross necropsies were performed on all animals at the termination of the study.
Value LD50 or LC50 with confidence limits	>5000 mg/kg bw

Number of deaths at each dose level	1 at 5000 mg/kg bw
Remarks for results	The LD50 was reported to be >5000 mg/kg bw.
Conclusion remarks	The LD50 was reported to be >5000 mg/kg bw.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Moreno O. M. (1972) Acute oral toxicity of nerol in rats and rabbits. Unpublished report to RIFM.

Substance Name	Nerol
CAS	106-25-2
Remarks for Substance	Clear liquid
Method/guideline	NG
Test Type	Oral LD50
GLP	Not reported
Year	1972
Species/Strain	Rat/Wistar
Sex	Male
# of animals per sex per dose	10
Vehicle	None
Route of administration	Oral
Remarks for test conditions	Ten rats per dose level were administered 2560, 4000, 6250 or 9800 mg/kg bw nerol and observed for fourteen days. Gross necropsies performed on all survivors.
Value LD50 or LC50 with confidence limits	4500 mg/kg bw (95% C.L. 3400-5600 mg/kg bw)
Number of deaths at each dose level	2560 mg/kg bw 1/10 deaths; 4000 mg/kg bw 4/10 deaths; 6250 mg/kg bw 7/10 deaths; 9800 mg/kg bw 10/10 deaths
Remarks for results	The animals experienced axophthalmia, hyperreflexiveness, restlessness, lethargy and the loss of the righting reflex. Deaths occurred overnight to two days following administration of the test substance.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Moreno O. M. (1972) Acute oral toxicity of nerol in rats and rabbits. Unpublished report to RIFM.

Substance Name	Citral

CAS	5392-40-5
Remarks for Substance	Substance supported under SIDS.
Method/guideline	Litchfield-Wilcoxon, 1949
Test Type	Oral LD50
GLP	Not reported
Year	1964
Species/Strain	Rat/Osborne-Mendel
Sex	Male and Female
# of animals per sex per dose	5
Vehicle	None
Route of administration	Intubation
Remarks for test conditions	5 male and 5 female young adult Osborne-Mendel rats were fasted for 18 hours prior to treatment. Animals were observed for toxic signs and death. The observation period was 2 wks.
Value LD50 or LC50 with confidence limits	4960 mg/kg bw (95% C.L. 3940-6240)
Number of deaths at each dose level	Not reported
Remarks for results	Slope function: 1.5 (95% C.L. 1.2-2.0). Toxic signs were depression. Times of deaths were between 4-96 hours.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study.
References	Jenner P.M., Hagan E.C., Taylor J.M., Cook E.L., Fitzhugh O.G. (1964) Food flavorings and compounds of related structure I. Acute Oral Toxicity. Fd. Cosmet. Toxicol. 2, 327-343.

Substance Name	Acetylated myrcene (data given for major component, geranyl acetate)
CAS	68412-04-4
Remarks for Substance	Principal component of acetylated myrcene
Method/guideline	Litchfield-Wilcoxon, 1949
Test Type	Oral LD50
GLP	Not reported
Year	1964
Species/Strain	Rat/Osborne-Mendel

Sex	Male and Female
# of animals per sex per dose	5
Vehicle	None
Route of administration	Intubation
Remarks for test conditions	5 male and 5 female young adult Osborne-Mendel rats were fasted for 18 hours prior to treatment. Animals were observed for toxic signs and death. The observation period was 2 weeks.
Value LD50 or LC50 with confidence limits	6330 mg/kg bw (95% C.L. 5450-7340)
Number of deaths at each dose level	Not reported
Remarks for results	Slope function: 1.3 (95% C.L. 1.2-1.4). Toxic signs were depression. Times of deaths were between 4-96 hours.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study.
References	Jenner P.M., Hagan E.C., Taylor J.M., Cook E.L., Fitzhugh O.G. (1964) Food flavorings and compounds of related structure I. Acute Oral Toxicity. Fd. Cosmet. Toxicol. 2, 327-343.

4.2 *In Vitro* Genotoxicity

Substance Name	dl-citronellol
CAS	106-22-9
Method/guideline	Ames
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	No
Year	1979
Species/Strain	Salmonella typhimurium/TA 100 and TA98
Metabolic Activation	Rat liver microsome fraction S9 from Aroclor induced rats
Doses/concentration levels	0.05 - 100 microliters per plate
Statistical Methods	NG
Remarks for test conditions	After 48-hour incubation at 37 °C, each assay plate was counted. Routine positive control plates were prepared: sodium azide & picolonic acid were used as positive controls for TA100 and TA98. Plates with aflatoxin B1 were positive controls for experiments performed with activation by S9

Result	No mutagenic effects
Cytotoxic concentration	NG
Genotoxic effects	None
Statistical evaluations	NG
Conclusion remarks	No evidence of mutagenicity
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Comparable to guideline study with acceptable restrictions. Data were acquired prior to GLP or OECD guidelines but were obtained by standard methodology and published in a peer-reviewed journal.
References	Rockwell P. and Raw I. (1979) A mutagenic screening of various herbs, spices, and food additives. Nutrition and Cancer, 1(4), 10-15.

Substance Name	Geraniol
CAS	106-24-1
Remarks for Substance	99.4% purity
Method/guideline	Chromosomal Aberration test
Test Type	Non-bacterial
System of Testing	Chinese hamster fibroblast
GLP	No
Year	1984
Species/Strain	Chinese hamster fibroblast
Metabolic Activation	None
Doses/concentration levels	3 doses at different concentrations. The maximum dose was 125 ug/plate
Statistical Methods	None performed
Remarks for test conditions	Replicates performed if no dose response was observed. Intervals for testing were 24 and 48 hrs. The solvent used was DMSO. Untreated cells and solvent treated cells were negative controls. The incidence of chromosomal aberrations for negative controls was usually less than 3.0%. 100 metaphases were examined for incidence of aberrations and considered negative <4.9%, equivocal 5.0-9.9%, positive. >10.0%. If no reasonable dose-response relationships were found, additional experiments were conducted at similar dose levels.
Result	Equivocal. Polyploidization effects were observed. The incidence of polyploid cells at 48 hours after treatment was 8.0%. The incidence of chromosomal aberrations at 48 hours was 4.0% at 48 hours.

Cytotoxic concentration	Not given
Genotoxic effects	Polyploidization effects were observed.
Statistical evaluations	Not given
Remarks for results	The result was considered equivocal presumably based on the polyploidization effects observed. The incidence of chromosomal aberrations at 48 hours was in the range considered negative by the authors.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Test was conducted by standard methodology and published in a peer-reviewed journal. This study closely followed OECD guideline 473, except for metabolic activation and the lack of positive controls.
References	Ishidate M., Sofuni T., Yoshikawa K., Hayashi M., Nohmi T., Sawada M., Matsuoka A. (1984) Primary Mutagenicity Screening of Food Additives Currently Used in Japan. Food Chemical Toxicology. 22, 623-636.

Substance Name	Geraniol
CAS	106-24-1
Remarks for Substance	99.4% purity
Method/guideline	Ames
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	No
Year	1984
Species/Strain	Salmonella typhimurium/TA 92, TA1535, TA100, TA1537, TA94, TA98
Metabolic Activation	With and without rat liver microsome fraction S9 from PCB-induced Fisher rats
Doses/concentration levels	6 different concentrations, maximum tested 500 ug/plate
Statistical Methods	Not given
Remarks for test conditions	DMSO was used as the solvent. Results were considered positive if number of colonies found was at least twice the number found in the control.
Result	Negative
Cytotoxic concentration	Not specified
Genotoxic effects	Negative
Statistical evaluations	Not given
Conclusion remarks	No mutagenic effects

Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Ishidate M., Sofuni T., Yoshikawa K., Hayashi M., Nohmi T., Sawada M., Matsuoka A. (1984) Primary Mutagenicity Screening of Food Additives Currently Used in Japan. Food Chemical Toxicology. 22, 623-636.

Substance Name	Geraniol
CAS	106-24-1
Method/guideline	Ames
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	No
Year	1980
Species/Strain	Salmonella typhimurium/TA 98, TA 100, TA 1535 and TA 1537
Metabolic Activation	With and without rat liver microsome fraction S9 from Aroclor-induced rats
Doses/concentration levels	3 micromol/plate (462 ug/plate)
Statistical Methods	Not given
Remarks for test conditions	The solvent used was ethanol. Only one replicate was performed for the substances, which tested negative.
Result	No mutagenic effects.
Cytotoxic concentration	Not given
Genotoxic effects	None
Statistical evaluations	Not given
Conclusion remarks	No mutagenic activity.
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Remarks for Data Reliability	Does not meet important criteria of today's standard methods.
References	Florin I., Rutberg L., Curvall M., and Enzell C.R. (1980) Screening of tobacco smoke constituents for mutagenicity using the Ames test. Toxicology, 18, 219-232.

Substance Name	Geraniol
CAS	106-24-1
Remarks for Substance	99% purity
Method/guideline	Ames
Test Type	Reverse mutation

System of Testing	Bacterial
GLP	No
Year	1980
Species/Strain	Salmonella typhimurium/TA100
Metabolic Activation	With and without rat liver microsome fraction S9 from Aroclor induced rats
Doses/concentration levels	0.01-1 microliter per 2ml DMSO
Statistical Methods	Not given
Remarks for test conditions	Values are average of two experiments. Positive controls were 6.5 µg sodium azide per 2 ml incubation volume w/out activation and 25 µg 2-aminoanthracene per 2 ml incubation volume with activation. Dose = 0.01 - 1 ul per 2 ml incubation volume in DMSO.
Result	No mutagenic effects
Cytotoxic concentration	Not given
Genotoxic effects	None
Statistical evaluations	Not given
Conclusion remark	No mutagenic activity
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Eder E., Nedecker T., Lutz D., Henschler D. (1980) Mutagenic potential of allyl and allylic compounds. Biochemical Pharmacology 29, 993-998.

Substance Name	Citral
CAS	5392-40-5
Remarks for Substance	Volunteered under SIDS program. 98.2% purity.
Method/guideline	Chromosomal Aberration test
Test Type	Non-bacterial
System of Testing	Chinese hamster fibroblast cell line
GLP	No
Year	1984
Species/Strain	Chinese hamster fibroblast
Metabolic Activation	None
Doses/concentration levels	3 doses at different concentrations. The maximum dose was 30 ug/plate
Statistical Methods	None performed

Remarks for test conditions	Replicates performed if no dose response was observed. Intervals for testing were 24 and 48 hrs. The solvent used was DMSO. Untreated cells and solvent treated cells were negative controls. The incidence of chromosomal aberrations for negative controls was usually less than 3.0%. 100 metaphases were examined for incidence of aberrations and considered negative. <4.9%, equivocal 5.0-9.9%, positive. >10.0%. If no reasonable dose-response relationships were found, additional experiments were conducted at similar dose levels.
Result	Negative. The incidence of polyploid cells at 48 hours after treatment was 4.0%. The incidence of chromosomal aberrations at 48 hours was 2.0%.
Cytotoxic concentration	Not given
Genotoxic effects	Negative
Statistical evaluations	Not given
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Test was conducted by standard methodology and published in a peer-reviewed journal. This study closely followed OECD guideline 473, except for metabolic activation and the lack of positive controls.
References	Ishidate M., Sofuni T., Yoshikawa K., Hayashi M., Nohmi T., Sawada M., Matsuoka A. (1984) Primary Mutagenicity Screening of Food Additives Currently Used in Japan. Food Chemical Toxicology. 22, 623-636.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	Acetylated myrcene is a mixture that is primarily (62%) acetate esters of nerol and geraniol. Purity of test substance for this assay was 69.6%.
Method/guideline	Ames
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	Not given
Year	1986
Species/Strain	Salmonella typhimurium/TA1535, TA1537, TA97, TA98, TA100
Metabolic Activation	With and without rat and hamster liver microsome fraction S9 from Aroclor-induced rats and hamsters, respectively.
Doses/concentration levels	1-3333 micrograms/plate
Statistical Methods	None employed
Remarks for test conditions	Positive controls included the following: sodium azide for TA1535 and TA100; 4-nitro-o-phenylenediamine for TA98; 9-

	aminoacridine for TA97 and TA1537; 2-aminoanthracene for all strains with hamster and rat liver metabolic activation. At least 5 dose levels were tested, with 3 plates per dose level. All assays were repeated at least one week following initial assay.
Result	No mutagenic effects.
Cytotoxic concentration	Not given
Genotoxic effects	None
Statistical evaluations	Not given
Conclusion remarks	No evidence of mutagenicity.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study. Test was conducted by laboratory under contract with the National Toxicology Program.
References	Mortelmans, K., Haworth, S., Lawlor, T., Speck, W., Tainer, B., and Zeiger, E. (1986). Salmonella mutagenicity tests: II. Results from the testing of 270 chemicals. Environmental Mutagenesis 8(7), 1-119.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	Acetylated myrcene is a mixture that is primarily (62%) acetate esters of nerol and geraniol.
Method/guideline	Ames
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	No
Year	1989
Species/Strain	Salmonella typhimurium/TA1535, TA1537, TA1538, TA98, TA100
Metabolic Activation	Rat liver microsome fraction S9 from Aroclor-induced rats
Doses/concentration levels	20000 ug/plate
Statistical Methods	Not given
Remarks for test conditions	After two days incubation at 37 °C, revertant colonies were counted.
Result	No mutagenic effects.
Cytotoxic concentration	Not given
Genotoxic effects	None
Statistical evaluations	Not given
Conclusion remarks	No evidence of mutagenicity

Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study.
References	Heck, J. D., Vollmuth, T. A., Cifone, M. A., Jagannath, D. R., Myhr B., and R.D. Curren (1989). An evaluation of food flavoring ingredients in a genetic toxicity screening battery The Toxicologist, 9(1), 257.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	Acetylated myrcene is a mixture that is primarily (62%) acetate esters of nerol and geraniol.
Method/guideline	Unscheduled DNA Synthesis (UDS) Test with Mammalian Liver Cells In Vitro Unscheduled DNA Synthesis
Test Type	Unscheduled DNA Synthesis (Butterworth, 1987)
System of Testing	F344 rat hepatocytes
GLP	No
Year	1989
Species/Strain	Rat/ Adult male Fisher 344
Metabolic Activation	None
Doses/concentration levels	100 nanoliters/millilitre (nl/ml)
Statistical Methods	Not given
Remarks for test conditions	Cultures of freshly prepared hepatocytes were incubated with the test article for 18-20 hours. Cell survival was measured by concurrent cell counting and measurement of LDH release from cells. UDS was measured by counting nuclear grains and subtracting average grain counts in three adjacent nuclear-sized cytoplasmic areas. This was designated the net nuclear grain count (NNG). An NNG in excess of 6 grains was considered a positive response.
Result	No unscheduled DNA synthesis observed.
Cytotoxic concentration	Not given
Genotoxic effects	None
Statistical evaluations	Not given
Conclusion remarks	No evidence of genotoxicity
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study.
References	Heck, J. D., Vollmuth, T. A., Cifone, M. A., Jagannath, D. R., Myhr B., and R.D. Curren (1989). An evaluation of food flavoring ingredients in a genetic toxicity screening battery The Toxicologist, 9(1), 257.

4.3 In Vivo Genotoxicity

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	Acetylated myrcene is a mixture that is primarily (62%) acetate esters of nerol and geraniol. The test substance in this study was geranyl acetate (CAS 105-87-3) obtained from the National Toxicology Program Repository. Purity tests revealed the test substance; acetylated myrcene consisted of 79% geranyl acetate and 21% citronellyl acetate. Remaining impurities accounted for less than 0.37%.
Method/guideline	Mouse bone marrow micronucleus assay
Test Type	Micronucleus
GLP	NG
Year	1993
Species/Strain	Mouse/ B6C3F1
Sex	Male
Route of Administration	Intraperitoneal injection
Doses/concentration	0, 450, 900, or 1800
Exposure period	3 days
Remarks for test conditions	Groups of five to six mice each were administered 0, 450, 900 or 1800 mg/kg bw by intraperitoneal injection for three consecutive days. Positive and negative controls were also maintained. Positive controls were either DMBA (7,12-dimethylbenzanthracene) in corn oil or MMC (mitomycin C) in PBS. 48 hr after the last treatment the mice were euthanized. Bone marrow and peripheral blood smears were obtained by a direct technique

Effect on mitotic index or PCE/NCE ratio by dose level and sex

Dose	MN-PCE/1000	# Animals	Pairwise Comparison	Survival	PCE
0	2.20 +/-0.26	5		5/5	65.0
450	2.50 +/-0.42	5	0.3307	5/5	62.1
900	3.30+/-1.06	5	0.0687	5/5	66.3
1800	2.83+/-0.56	6	0.1766	6/6	67.3

Genotoxic effects	Negative
NOEL (C)/ LOEL (C)	NOEL=1800 mg/kg bw
Statistical evaluations	Yes, trend test and pairwise comparison alpha=0.05
Remarks for results	The initial test was negative to the high dose and was not repeated.
Conclusion	The test was negative.

Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Basic data given and comparable to guidelines/standards.
References	Shelby M.D., Erexson G.L., Hook G.J., and Tice R.R. (1993) Evaluation of a Three-Exposure Mouse Bone Marrow Micronucleus Protocol; Results with 49 Chemicals. Enviromental and Molecular Mutagenesis, 21: 160-179.

Substance	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	Acetylated myrcene is a mixture that is primarily (62%) acetate esters of nerol and geraniol.
Method/guideline	Unscheduled DNA Synthesis (UDS) Test with Mammalian Liver Cells In Vivo
Test Type	Unscheduled DNA
GLP	NG
Year	1983
Species/Strain	Rat/Fischer 344
Sex	Male
Route of Administration	Gavage
Genotoxic effects	No genotoxic effects.
Conclusion	No evidence of genotoxicity.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study. Data considered reliable and followed OECD guideline 486.Test was conducted by laboratory under contract with the National Toxicology Program.
References	Mirsalis, J., Tyson, K., Beck, J., Loh, E., Steinmetz, K., Contreras, C., Austere, L.,Martin, S., and J.Spalding (1983). Induction of unscheduled DNA synthesis (UDS) in hepatocytes following in vitro and in vivo treatment. Environmental Mutagenesis 5(3), 482.

4.4 Repeat Dose Toxicity

Substance Name	Citronellol
CAS	106-22-9
Remarks for Substance	Mixture of citronellol (50%) and linalool (50%)
Method/guideline	The test mixture was incorporated in the ration at a level designed to provide daily in the food 100 mg of the flavor blend per kg of body wt. The un-supplemented diet was fed to the controls. The rats were fed for 12 weeks

GLP	Pre-GLP
Year	1958
Species/Strain	Unspecified strain rat
Sex	Male and Female
Route of administration	Diet
Doses/concentration levels	100 mg/kg of mixture per day
Exposure period	12 weeks
Frequency of treatment	Continuously in diet
Control Group	Yes
Post exposure observation period	NG
Remarks for test conditions	After 12 weeks on test, the urine of 3 rats of each sex per group was examined for the presence of sugar and albumin, blood hemoglobin levels were determined and autopsies were performed on all animals.
NOAEL(NOEL)	100 mg/kg bw/day ppm
LOAEL(LOEL)	No adverse effects at highest dose
Actual dose received by dose level and sex	Not given
Toxic response/effects by dose level	No adverse effects on efficiency of food utilization or other observable physiological criteria were noted.
Statistical evaluations	Not given
Remarks for results	The depression in the growth and food intake of the male rats was attributed to impalatibility of the test material at the level administered.
Conclusion remarks	Feeding tests with a mixture of equal parts of citronellol and linalool fed at a level 100 times the estimated use level in the diet disclosed no adverse effect on efficiency of food utilization or other observable criteria..
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
References	Oser, B. (1958) Toxicological Screening of Components of Food Flavors Class VI. Citronellol and Linalool. Food and Drug Research Laboratories.

Substance Name	Geraniol
CAS	106-24-1
Remarks for Substance	Mixture of 3,7-dimethyl-2,6-octadienol (geraniol) and 3,7-dimethyl-6-octenol (citronellol)

Method/guideline	Screening method used by U.S. Food and Drug Administration
GLP	No
Year	1967
Species/Strain	Osborne-Mendel rats
Sex	Male and Female
Route of administration	Diet
Doses/concentration levels	1000 or 10000 ppm
Exposure period	112 days at 10,000 ppm, 189-196 days at 1000 ppm
Frequency of treatment	Continuously in diet
Control Group	Yes
Post exposure observation period	NG
Remarks for test conditions	Groups of five male and five female Osborne-Mendel rats were provided geraniol in the diet at concentrations of 0, 1000 or 10,000 ppm for 16 and 27-28 weeks, respectively. No vehicle was used. The diet was prepared and analyzed weekly. Measurements of body weight, food intake and general condition were recorded weekly. Hematological examinations (white cell counts, red cell counts, hemoglobins and hematocrits) were performed at the termination of the study. Macroscopic examination of all tissues was performed. Histopathological examination was performed on the liver, kidneys, spleen, heart, and testes of 6-8 animals (evenly divided by sex) from both doses and the control dose group.
NOAEL(NOEL)	10000 ppm
LOAEL(LOEL)	No adverse effects at highest dose
Actual dose received by dose level and sex	Not given
Toxic response/effects by dose level	None
Statistical evaluations	Not given
Remarks for results	Measurements of body weight, food intake and general condition recorded weekly showed no significant differences between test and control animals at any intake level. At termination, hematological examinations revealed no difference from controls. At necropsy, no differences were reported between major organ weights of test and control animals. Gross examination of tissue of all animals was unremarkable and histopathological examination revealed no treatment-related lesions.
Conclusion remarks	This study demonstrates a NOAEL in rats of at least 500 mg/kg/day.

Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study. This study was performed by the FDA prior to the establishment of GLP and OECD.
References	Hagan E.C., Hansen W.H., Fitzhugh O.G., Jenner P.M., Jones W.I., Taylor J.M., Long E.L., Nelson A.A., and Brouwer J.B. (1967) Food Flavourings and Compounds of Related Structure. II. Subacute and Chronic Toxicity. Food Cosmetic Toxicology 5, 141-157.

Substance Name	Citral
CAS	5392-40-5
Remarks for Substance	Substance supported under SIDS.
Method/guideline	Screening method used by U.S. Food and Drug Administration.
GLP	No
Year	1967
Species/Strain	Osborne-Mendel rats
Sex	Male and Female
Route of administration	Diet
Doses/concentration levels	1000, 2500 or 10000 ppm
Exposure period	91 days
Frequency of treatment	Continuously in diet
Control Group	Yes
Post exposure observation period	Not given
Remarks for test conditions	Groups of ten male and ten female Osborne-Mendel rats were provided citral in the diet at concentrations of 0, 1000, 2500 or 10,000 ppm for 13 weeks. No vehicle was used. The diet was prepared and analyzed weekly. Measurements of body weight, food intake and general condition were recorded weekly. Hematological examinations (white cell counts, red cell counts, hemoglobins and hematocrits) were performed at the termination of the study. Macroscopic examination of all tissues was performed. Histopathological examination was performed on the liver, kidneys, spleen, heart, and testes of. 6-8 animals (evenly divided by sex) from the high dose and control dose groups.
NOAEL(NOEL)	10000 ppm
LOAEL(LOEL)	No adverse effects at highest dose
Actual dose received by dose level and sex	Not given
Toxic response/effects by	None.

dose level	
Statistical evaluations	Not given
Remarks for results	Determination of the dietary concentration of citral revealed a weekly loss of 58% therefore the average daily dose received is estimated to be about 200 mg/kg based on an assumed daily intake of food of 50g/kg. Measurements of body weight, food intake and general condition recorded weekly showed no significant differences between test and control animals at any intake level. At termination, hematological examinations revealed no difference from controls. At necropsy, no differences were reported between major organ weights of test and control animals. Gross examination of tissue of all animals was unremarkable and histopathological examination revealed no treatment-related lesions.
Conclusion remarks	This study demonstrates a NOAEL in rats of at least 200 mg/kg/day.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study. This study was performed by the FDA prior to the establishment of GLP and OECD.
References	Hagan E.C., Hansen W.H., Fitzhugh O.G., Jenner P.M., Jones W.I., Taylor J.M., Long E.L., Nelson A.A., and Brouwer J.B. (1967) Food Flavourings and Compounds of Related Structure. II. Subacute and Chronic Toxicity. Food Cosmetic Toxicology 5, 141-157.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	Acetylated myrcene is a mixture that is primarily (62%) acetate esters of nerol and geraniol. The test substance under study is geranyl acetate (CAS 105-87-3).
Method/guideline	Screening method used by U.S. Food and Drug Administration
GLP	Not given
Year	1967
Species/Strain	Osborne-Mendel rats
Sex	Male and Female
Route of administration	Diet
Doses/concentration levels	1000, 2500 or 10000 ppm
Exposure period	118 days
Frequency of treatment	Continuously in diet
Control Group	Yes
Post exposure observation period	Not given
Remarks for test conditions	Groups of ten male and ten female Osborne-Mendel rats were

	provided geranyl acetate in the diet at concentrations of 0, 1000, 2500 or 10,000 ppm for 17weeks. No vehicle was used. The diet was prepared and analyzed weekly. Measurements of body weight, food intake and general condition were recorded weekly. Hematological examinations (white cell counts, red cell counts, hemoglobins and hematocrits) were performed at the termination of the study. Macroscopic examination of all tissues was performed. Histopathological examination was performed on the liver, kidneys, spleen, heart, and testes of 6-8 animals (evenly divided by sex) from the high dose and control dose groups.
NOAEL(NOEL)	10000 ppm
LOAEL(LOEL)	No adverse effects at highest dose
Actual dose received by dose level and sex	Not given
Toxic response/effects by dose level	None.
Statistical evaluations	Not given
Remarks for results	Determination of the dietary concentration of geranyl acetate revealed a weekly loss of 4%. The average daily dose received is estimated to be about 500 mg/kg based on an assumed daily intake of food of 50g/kg. Measurements of body weight, food intake and general condition recorded weekly showed no significant differences between test and control animals at any intake level. At termination, hematological examinations revealed no difference from controls. At necropsy, no differences were reported between major organ weights of test and control animals. Gross examination of tissue of all animals was unremarkable and histopathological examination revealed no treatment-related lesions.
Conclusion remarks	This study demonstrates a NOAEL in rats of at least 500 mg/kg/day.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study. This study was performed by the FDA prior to the establishment of GLP and OECD.
References	Hagan E.C., Hansen W.H., Fitzhugh O.G., Jenner P.M., Jones W.I., Taylor J.M., Long E.L., Nelson A.A., and Brouwer J.B. (1967) Food Flavourings and Compounds of Related Structure. II. Subacute and Chronic Toxicity. Food Cosmetic Toxicology 5, 141-157.
Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	Acetylated myrcene is a mixture that is primarily (62%) acetate esters of nerol and geraniol. The test substance was food grade

	geranyl acetate (CAS 105-87-3). Purity tests revealed the test substance consisted of 79% geranyl acetate and 29% citronellyl acetate. Remaining impurities accounted for less than 0.37%.
Method/guideline	National Toxicology Program Carcinogenesis study (NIH Publication No. 88-2508) or (NTP TR 252).
GLP	Yes
Year	1987
Species/Strain	F344/N rats
Sex	Male and Female
Route of administration	Gavage
Doses/concentration levels	1000 or 2000 mg/kg bw/d
Exposure period	103 weeks
Frequency of treatment	Daily (5 days/week)
Control Group	Yes
Post exposure observation period	Not given
Remarks for test conditions	A carcinogenicity study was conducted in which groups of 50 F344/N rats of each sex were administered 0, 1000, or 2000 mg/kg bw of a mixture of geranyl acetate (79%) and citronellyl acetate (29%) in corn oil by gavage daily, 5 days/week for 103 weeks. Body weights were recorded weekly for the first 12 weeks and monthly thereafter. Necropsies were performed on all animals surviving until the end of the study and on all animals found dead during the study. Histopathological examination was conducted on the following: gross lesions, tissue masses, abnormal lymph nodes, skin, mandibular lymph nodes, mammary gland, salivary gland, thigh muscle, sciatic nerve, bone marrow, thymus, larynx, trachea, lungs, and bronchi, heart, thyroid, parathyroid, esophagus, stomach, duodenum, jejunum, ileum, colon, mesenteric lymph nodes, liver, pancreas, spleen, kidneys, adrenals, urinary bladder, seminal vesicles/prostate/testes or ovaries/uterus, brain, pituitary, and spinal cord.
NOAEL(NOEL)	2000 mg/kg bw/d
Actual dose received by dose level and sex	Not applicable
Toxic response/effects by dose level	A statistically significant decrease in mean body weights was reported for high-dose male rats throughout the study and dosed female rats after week 40. Reduced mean body weight gains were dose related. Survival of the high-dose group (18/50) of male rats was significantly less than the controls (34/50; p=0.001) and the low-dose group (29/50; p=0.003). There was no other significant difference in survival between any groups of either sex. There was a statistically significant ($p<0.05$) increase in the incidence of squamous cell neoplasms (combined papillomas and carcinomas) in low-dose male rats,

but not in the high-dose group (controls, 0/50; low dose, 5/50; high dose, 1/50) or any group of female rats. A positive trend (controls, 6/50: low dose, 8/50; high dose, 9/50) in the incidence of adrenal pheochromocytomas in male rats was not statistically significant. Two (2) low-dose male rats had tubular cell adenomas, but none were observed in the controls or the high-dose group. There was no significant increase in the incidence of any neoplasms in high-dose male or female rats compared to the control groups. The incidence of mammary gland fibroadenomas in high-dose female rats was significantly less (pairwise comparisons, $p<0.002$) than those in the control group (controls, 12/50; high dose, 1/50). Based on pair-wise comparisons between high-dose and control groups of male rats, there was a significant decrease ($p<0.02$, Fisher) in the incidence of pituitary adenomas in high-dose males (controls, 10/50; high dose, 2/50). Based on life table analysis of male rats, the incidence of adenomas was not significantly different between control and high-dose groups. A negative trend (controls, 4/49: low dose, 3/48; high dose, 0/50) was observed in the incidence of pancreatic islet-cell adenomas and carcinomas in male rats, but was not statistically significant based on pairwise comparisons between control and dosed groups.

Statistical evaluations

Not given

Remarks for results

A statistically significant decrease in mean body weights was reported for high-dose male rats throughout the study and dosed female rats after week 40. Reduced mean body weight gains were dose related. Survival of the high-dose group (18/50) of male rats was significantly less than the controls (34/50; $p=0.001$) and the low-dose group (29/50; $p=0.003$). There was no other significant difference in survival between any groups of either sex. There was a statistically significant ($p<0.05$) increase in the incidence of squamous cell neoplasms (combined papillomas and carcinomas) in low-dose male rats, but not in the high-dose group (controls, 0/50; low dose, 5/50; high dose, 1/50) or any group of female rats. A positive trend (controls, 6/50: low dose, 8/50; high dose, 9/50) in the incidence of adrenal pheochromocytomas in male rats was not statistically significant. Two (2) low-dose male rats had tubular cell adenomas, but none were observed in the controls or the high-dose group. There was no significant increase in the incidence of any neoplasms in high-dose male or female rats compared to the control groups. The incidence of mammary gland fibroadenomas in high-dose female rats was significantly less (pairwise comparisons, $p<0.002$) than those in the control group (controls, 12/50; high dose, 1/50). Based on pair-wise comparisons between high-dose and control groups of male rats, there was a significant decrease ($p<0.02$, Fisher) in the incidence of pituitary adenomas in high-dose males (controls, 10/50; high dose, 2/50). Based on life table analysis of male rats, the incidence of adenomas was not significantly different between control and high-dose groups. A negative trend (controls, 4/49: low dose, 3/48; high dose, 0/50) was observed in the incidence of pancreatic islet-cell adenomas and carcinomas in male rats, but was not statistically significant

	based on pairwise comparisons between control and dosed groups [NTP, 1987]. The increases in the incidence of squamous cell papillomas and carcinomas, adrenal pheochromocytomas, and renal tubular adenomas in male rats were not dose related. These types of tumors occur commonly in male F344 rats. The overall incidence of these commonly observed adrenal pheochromocytomas and squamous cell tumors in paired control groups of male rats have been reported to be 25.1% and 3.7%, respectively [Haseman et al., 1986]. Under conditions of this study, geranyl acetate was not carcinogenic for either sex of F344/N rats [NTP, 1987]. In summary, no significant toxic or carcinogenic effects were reported when a mixture of geranyl acetate and citronellyl acetate was administered at dose levels up to 2000 mg/kg bw/d to rats, which correspond to estimated dose levels of 1420 mg geranyl acetate/kg bw/d and 580 mg citronellyl acetate/kg bw/d (the estimated dose levels correspond to 71% and 29% of the administered dose which are the fractions of geranyl acetate and citronellyl acetate contained in the mixture).
Conclusion remarks	Under conditions of this study, the mixture of geranyl acetate and citronellyl acetate was not carcinogenic for either sex of B6C3F1 mice.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study. This study was performed by the NTP.
References	National Toxicology Program (NTP) (1987) Carcinogenesis studies of food grade geranyl acetate (71%) and citronellyl acetate (29%). NTP-TR-252. National Technical Information Services. PB-88-2508.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	Acetylated myrcene is a mixture that is primarily (62%) acetate esters of nerol and geraniol. The test substance in this study was food grade geranyl acetate (CAS 105-87-3). Purity tests revealed the test substance consisted of 79% geranyl acetate and 29% citronellyl acetate. Remaining impurities accounted for less than 0.37%.
Method/guideline	National Toxicology Program Carcinogenesis study (NIH Publication No. 88-2508) or (NTP TR 252).
GLP	Yes
Year	1987
Species/Strain	Mouse/B6C3F1
Sex	Male and Female
Route of administration	Gavage
Doses/concentration levels	500 or 1000 mg/kg bw/d
Exposure period	103 weeks
Frequency of treatment	Daily (5 days/week)

Control Group	Yes
Post exposure observation period	Not given
Remarks for test conditions	A carcinogenicity study was conducted in which groups of 50 B6C3F1 mice of each sex were administered 0, 500, or 1000 mg/kg bw of a mixture of geranyl acetate (79%) and citronellyl acetate (29%) in corn oil by gavage daily, 5 days/week for 103 weeks. Body weights were recorded weekly for the first 12 weeks and monthly thereafter. Necropsies were performed on all animals surviving until the end of the study and on all animals found dead during the study. Histopathological examination was conducted on the following: gross lesions, tissue masses, abnormal lymph nodes, skin, mandibular lymph nodes, mammary gland, salivary gland, thigh muscle, sciatic nerve, bone marrow, thymus, larynx, trachea, lungs, and bronchi, heart, thyroid, parathyroid, esophagus, stomach, duodenum, jejunum, ileum, colon, mesenteric lymph nodes, liver, gallbladder, pancreas, spleen, kidneys, adrenals, urinary bladder, seminal vesicles/prostate/testes or ovaries/uterus, brain, pituitary, and spinal cord.
NOAEL(NOEL)	1000 mg/kg bw/d
LOAEL(LOEL)	>1000 mg/kg bw/d
Actual dose received by dose level and sex	Not applicable
Toxic response/effects by dose level	Mean body weights of high-dose male and female mice were lower than those of control groups after week 18 of the study. Survival of male mice in the high-dose group was significantly reduced (controls, 31/50; high dose, 0/50). Survival of the high- and low-dose groups of female mice was significantly less ($p<0.001$; low dose, 0.020) than that of the control group (controls, 28/50; low dose, 15/50; high dose, 0/50). Inflammation of the vagina, uterus, ovaries, or multiple organs occurred in 18 control, 14 low-dose, and 2 high-dose female mice. The incidence of malignant lymphoma in high-dose male mice was significantly less ($p<0.044$) than in the control group (controls, 7/50; high dose, 1/50). There was a significant ($p=0.030$, Fisher) decrease in the incidence of thyroid follicular-cell adenoma in high dose female mice (controls, 7/50; high dose, 1/50). The incidence of non-neoplastic lesions was significantly increased in high-dose male and female mice only; an increased incidence of cytoplasmic vacuolization of the liver in male (control, 1/50; low dose, 7/50; high dose, 47/50) and female mice (control, 1/50; low dose, 27/50; high dose, 46/50) and the kidney or kidney tubule in male (control, 0/50; low dose, 0/50; high dose, 41/50) and female mice (control, 0/50; low dose, 24/49; high dose, 37/50).
Statistical evaluations	Not given
Remarks for results	The probable cause of death of many females was a genital tract infection. Inflammation of the vagina, uterus, ovaries, or multiple organs occurred in 18 control, 14 low-dose, and 2 high-dose female mice. Although the etiologic agent was not isolated, Klebsiella pneumoniae were isolated from similarly affected mice at this laboratory in subsequent chronic studies.

	Surviving male (36) and female (11) mice in the high-dose groups were killed in a moribund condition at week 91 after an inadvertent overdose of the test substance. Eleven other animals (3 control males, 3 low-dose males, 3 low-dose females and 2 high-dose females) were killed by gavage accidents during the course of the study. There was no increase in the incidence of neoplastic lesions associated with administration of the test substance. The incidence of non-neoplastic lesions was significantly increased in high-dose male and female mice only; an increased incidence of cytoplasmic vacuolization of the liver in male (control, 1/50; low dose, 7/50; high dose, 47/50) and female mice (control, 1/50; low dose, 27/50; high dose, 46/50) and the kidney or kidney tubule in male (control, 0/50; low dose, 0/50; high dose, 41/50) and female mice (control, 0/50; low dose, 24/49; high dose, 37/50).
Conclusion remarks	Under conditions of this study, the mixture of geranyl acetate and citronellyl acetate was not carcinogenic for either sex of B6C3F1 mice.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study. This study was performed by the NTP.
References	National Toxicology Program (NTP) (1987) Carcinogenesis studies of food grade geranyl acetate (71%) and citronellyl acetate (29%). NTP-TR-252. National Technical Information Services. PB-88-2508.

Substance Name	Acetylated myrcene
CAS	68412-04-4
Remarks for Substance	Acetylated myrcene is a mixture that is primarily (62%) acetate esters of nerol and geraniol. The test substance in this study was food grade geranyl acetate (CAS 105-87-3). Purity tests revealed the test substance consisted of 79% geranyl acetate and 29% citronellyl acetate. Remaining impurities accounted for less than 0.37%.
Method/guideline	National Toxicology Program Carcinogenesis study (NIH Publication No. 88-2508) or (NTP TR 252).
GLP	Yes
Year	1987
Species/Strain	B6C3F1 mice
Sex	Male and Female
Route of administration	Gavage
Doses/concentration levels	125, 250, 500, 1000, or 2000 mg/kg bw/d
Exposure period	13 weeks
Frequency of treatment	Daily (5 days/week)
Control Group	Yes

Post exposure observation period	Not given
Remarks for test conditions	In a 13-week study, a mixture of geranyl acetate (71%) and citronellyl acetate (29%) was administered by gavage in corn oil to six groups of B6C3F1 mice (10/sex/group) at dose levels of 0, 125, 250, 500, 1000, or 2000 mg/kg bw daily 5 days/week. Animals were checked twice daily for mortality and signs of morbidity. Body weight data were collected weekly. Necropsies were performed on all animals surviving until the end of the study and on all animals found dead during the study. Histopathologic examination was conducted on the following organs for the 2000 mg/kg bw/d dose group and the control groups: gross lesions, tissue masses, abnormal lymph nodes, skin, mandibular lymph nodes, mammary gland, salivary gland, thigh muscle, sciatic nerve, bone marrow, thymus, larynx, trachea, lungs, and bronchi, heart, thyroid, parathyroid, esophagus, stomach, duodenum, jejunum, ileum, colon, mesenteric lymph nodes, liver, gallbladder, pancreas, spleen, kidneys, adrenals, urinary bladder, seminal vesicles/prostate/testes or ovaries/uterus, brain, pituitary, and spinal cord.
NOAEL(NOEL)	1000 mg/kg bw/d
LOAEL(LOEL)	2000 mg/kg bw/d
Actual dose received by dose level and sex	NA
Toxic response/effects by dose level	Seven (7) of 10 males and 9/10 females receiving 2000 mg/kg bw/d died during the study. Male and female mice in the 2000 mg/kg bw/d dose groups exhibited cytoplasmic vacuolization of the liver, kidney and myocardium.
Statistical evaluations	Not given
Remarks for results	Gavage errors resulted in the death of three females at lower dose levels. Mean body weights were comparable for dosed and control animals. Male and female mice in the 2000 mg/kg bw/d dose groups exhibited cytoplasmic vacuolization of the liver, kidney and myocardium. Vacuolization was the result of lipid droplets that were present throughout the liver lobule, particularly in the periportal region. No treatment-related histopathological lesions or other effects were observed in the 1000 mg/kg bw/d group.
Conclusion remarks	This study demonstrates a NOAEL in mice of 1000 mg/kg bw/day.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study. This study was performed by the NTP.
References	National Toxicology Program (NTP) (1987) Carcinogenesis studies of food grade geranyl acetate (71%) and citronellyl acetate (29%). NTP-TR-252. National Technical Information Services. PB-88-2508.

Substance Name	Acetylated myrcene

CAS	68412-04-4
Remarks for Substance	Acetylated myrcene is a mixture that is primarily (62%) acetate esters of nerol and geraniol. The test substance in this study was food grade geranyl acetate (CAS 105-87-3). Purity tests revealed the test substance consisted of 79% geranyl acetate and 29% citronellyl acetate. Remaining impurities accounted for less than 0.37%.
Method/guideline	National Toxicology Program Carcinogenesis study (NIH Publication No. 88-2508) or (NTP TR 252).
GLP	Yes
Year	1987
Species/Strain	Rat/F344/N
Sex	Male and Female
Route of administration	Gavage
Doses/concentration levels	250, 500, 1000, 2000 or 4000 mg/kg bw/d
Exposure period	13 weeks
Frequency of treatment	Daily (5 days/week)
Control Group	Yes
Post exposure observation period	NG
Remarks for test conditions	In a 13-week study, a mixture of geranyl acetate (71%) and citronellyl acetate (29%) was administered by gavage in corn oil to six groups of F344/N rats (10/sex/group) at dose levels of 0, 125, 250, 500, 1000, or 2000 mg/kg bw daily 5 days/week. Animals were checked twice daily for mortality and signs of morbidity. Body weight data were collected weekly. Necropsies were performed on all animals surviving until the end of the study and on all animals found dead during the study. Histopathologic examination was conducted on the following organs for the 2000 mg/kg bw/d dose group and the control groups: gross lesions, tissue masses, abnormal lymph nodes, skin, mandibular lymph nodes, mammary gland, salivary gland, thigh muscle, sciatic nerve, bone marrow, thymus, larynx, trachea, lungs, and bronchi, heart, thyroid, parathyroid, esophagus, stomach, duodenum, jejunum, ileum, colon, mesenteric lymph nodes, liver, pancreas, spleen, kidneys, adrenals, urinary bladder, seminal vesicles/prostate/testes or ovaries/uterus, brain, pituitary, and spinal cord.
NOAEL(NOEL)	2000 mg/kg bw/d
LOAEL(LOEL)	4000 mg/kg bw/d
Actual dose received by dose level and sex	NA
Toxic response/effects by dose level	Two of ten males and 1/10 females receiving 4000 mg/kg bw/d died. A decrease in mean body weight gain in males and females (19 % and 8% relative to controls, respectively) was

	reported at the 4000 mg/kg bw/d dose level.
Statistical evaluations	Not given
Remarks for results	Mean body weights were comparable for dosed and control animals, except for a decrease in mean body weight gain in males and females (19 % and 8% relative to controls, respectively) at the 4000 mg/kg bw/d dose level. No treatment-related histopathologic effects were observed at necropsy.
Conclusion remarks	This demonstrates a NOAEL in rats of 2000 mg/kg bw/day.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Guideline study. This study was performed by the NTP.
References	National Toxicology Program (NTP) (1987) Carcinogenesis studies of food grade geranyl acetate (71%) and citronellyl acetate (29%). NTP-TR-252. National Technical Information Services. PB-88-2508.

4.5 Reproductive Toxicity

Substance Name	Citral (Mixture of geranial and neral)
CAS	5392-40-5
Remarks for Substance	Volunteered under SIDS program.
Method/guideline	Not given
Test Type	Two generation
GLP	Not given
Year	1989
Species/Strain	Rat/ CR Sprague Dawley
Sex	Female
Route of administration	Oral
Duration of test	14 days prior to cohabitation; days 0 through 25 of presumed gestation; days 1-21 of lactation
Doses/concentration levels	50, 160, 500 mg/kg bw/d
Premating Exposure period for males	Not available
Premating Exposure period for females	14 days
Frequency of treatment	Continuous
Control Group and treatment	Yes
Remarks for test conditions	Thirty Sprague/Dawley/Charles River females rats were administered citral at dose levels of 0, 50, 160, and 500 mg/kg bw/d for 14 days prior to cohabitation, days 0-25 of presumed gestation and days 1-21 of lactation. Per group, fifteen rats were assigned to caesarean sectioning while the other fifteen

	were assigned natural delivery. Parameters evaluated for the adult female rats included clinical observation, estrous cycle, body weight and body weight change, feed consumption, mating and fertility, duration of gestation, delivery and maternal behavior, reproductive indices, and gross necropsy. Fetuses were evaluated for fetal wastage, body weight, sex and gross external examination. Pups were evaluated for clinical observations, body weight and gross necropsy.
NOAEL(NOEL)	50 mg/kg bw/d
LOAEL(LOEL)	160 mg/kg bw/d
Actual dose received by dose level and sex	Not available
Parental data and F1 as appropriate	At the 160 and 500 mg/kg bw/d dose levels, increased mortality (1/30 and 7/30, respectively), clinical signs of toxicity, significant decreases in body weight gain during gestation, and significant increases in feed consumption during lactation. No adverse effects were reported on estrous cycling, mating, fertility, duration of gestation, numbers of corpora lutea, number of implantations, live litter sizes, resorption of male/female ratio at dosages as high as 500 mg/kg bw/d.
Offspring toxicity F1 and F2	Decreases in fetal body weight (not statistically significant) were reported for fetuses delivered by Caesarean delivery, and significantly decreased pup body weight for delivered pups were reported at the 500 mg/kg bw/d level. No other effects were reported in the offspring.
Statistical evaluations	Yes, ANOVA F test
Remarks for results	The maternal NOAEL is 50 mg/kg bw/d and the fetal/pup NOAEL is 160 mg/kg bw/d.
Conclusion remarks	Citral did not affect the reproductive performance or the pre-weaning development of offspring in female Sprague/Dawley Charles River female rats.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study.
References	Hoberman, A.M., Christian, M.S., Bennett, M.B. and Vollmuth, T.A. (1989). Abstract. Oral general reproduction study of citral in female rats. The Toxicologist 9, 271.

4.6 Developmental/Teratogenicity Toxicity

Substance Name	Geraniol
CAS	106-24-1
Remarks for Substance	The test substance was citral diethyl acetal, the diethyl acetal of geranial.
Method/guideline	*In vivo* Reproductive and Developmental Tox. Screening Test

Test Type	*In vivo* mammalian test system
GLP	No
Year	1997
Species/Strain	Rat/Sprague Dawley
Sex	Female
Route of administration	Oral
Duration of test	39 days
Doses/concentration levels	0, 125, 250, 500 mg/kg bw/d
Exposure period	14 days
Frequency of treatment	Daily
Control Group and treatment	Vehicle alone
Remarks for test conditions	The test substance was administered orally by gavage at the dose levels specified or the vehicle alone for seven days prior to cohabitation and then through cohabitation, gestation, delivery and a 4-day lactation/postparturation period. The vehicle was either corn oil or methylcellulose. Body weights, food consumption and clinical signs were recorded throughout the observation period. All dams were necropsied and examined for gross lesions on Day 25 of presumed gestation for rats not delivering a litter and four days postpartum for rats delivering a litter. Pups delivered were sacrificed on day 4 postpartum, any pups dying during the lactation period were necropsied.
NOAEL(NOEL) maternal	125 mg/kg bw/d
LOAEL(LOEL) maternal	250 mg/kg bw/d
NOAEL (NOEL) developmental	250 mg/kg bw/d
LOAEL (LOEL) developmental	500 mg/kg bw/d
Actual dose received by dose level and sex	Not given
Maternal data with dose level	125 mg/kg bw/d- no effects; 250 mg/kg bw/d-clinical observations, body weight decrease compared to control, reduced body weight gain compared to control; 500 mg/kg bw/d-clinical observations, body weight decrease compared to control, reduced body weight gain compared to control
Fetal data with dose level	125 mg/kg bw/d-no effects; 250 mg/kg bw/d-no effects; 500 mg/kg bw/d-body weight decrease compared to control
Statistical evaluations	Bartlett's test of homogeneity, ANOVA (F-test); alpha= 0.05
Conclusion remarks	The NOAEL for maternal toxicity was reported to be 125 mg/kg bw/d, and the NOAEL for offspring toxicity was 250 mg/kg bw/d.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.

Remarks for Data Reliability	Acceptable, well documented publication, which meets basic scientific principles. Study duration shorter than guideline studies and less animals used.
References	Vollmuth T.A., Bennett, M.B., Hoberman, A.M. and Christian, M.S. (1995) An Evaluation of Food Flavoring Ingredients Using an In Vivo Reproductive and Developmental Toxicity Screening Test. Teratology 41(5): 597.

Substance Name	Citral
CAS	5392-40-5
Remarks for Substance	Substance supported under SIDS. 95% pure
Test Type	Embryo-feto toxicity
GLP	NG
Year	1995
Species/Strain	Wistar rats
Sex	Male and Female
Route of administration	Oral
Duration of test	21 days
Doses/concentration levels	0, 60, 125, 250, 500, and 1000 mg/kg bw in corn oil
Exposure period	Once a day for days 6-15 of pregnancy
Frequency of treatment	Daily
Control Group and treatment Remarks for test conditions	Yes, the control group received only corn oil. Citral was administered orally at the dose levels specified to female Wistar rats on days 6-15 of pregnancy. Caesarean sections were performed on day 21. Numbers of resorption and implantation sites were recorded. Fetuses were weighed and examined for gross malformations, visceral and skeletal malformations. Exposure to citral was limited to the main period of organogenesis.
NOAEL(NOEL) maternal	<60 mg/kg bw/d
LOAEL(LOEL) maternal	60 mg/kg bw/d
NOAEL (NOEL) developmental	<60 mg/kg bw/d
LOAEL (LOEL) developmental	60 mg/kg bw/d
Actual dose received by dose level and sex	NG
Maternal data with dose level	Statistically significant reductions in pregnancy weight gain (minus uterus weight) were reported for the two highest dose levels (500 and 1000 mg/kg bw/d) administered. Statistically significant differences in weight gain were reported for the other

	dose levels tested.
Fetal data with dose level	Statistically significant reductions in fetal body weight were reported for dose levels at 125, 250, and 500 mg/kg bw/d. Increases in the frequency of delayed ossifications were reported for the 125 and 250 mg/kg bw/d and were statistically significant. The incidence of hematomas was significantly increased in animals receiving 250, 500 or 1000 mg/kg bw/d. The only fetal organ with treatment related reductions in weight were spleens at doses of 250 mg/kg bw/d or higher. Statistically significant Increases in the number of fetuses showing skeletal abnormalities was reported for the 125, 250 and 1000 mg/kg bw/d dose levels. No treatment related effects were reported on the occurrence of gross structural abnormalities, or visceral malformations.
Statistical evaluations	One way ANOVA (F-test), or the Kruskal- Alpha value of 0.05.
Remarks for results	The authors hypothesized the later start day for treatment administration may have reduced in the induction of metabolic enzymes responsible for detoxification of citral.
Conclusion remarks	The NOAEL for developmental toxicity for citral is reported to be less than 60 mg/kg bw/d.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Acceptable, well documented publication, which meets basic scientific principles. Exposure to test material limited to main period of organogenesis.
References	Cristina A., Nogueira A.M., Carvalho R., Souza A., Chahoud I., Paumgartten F. (1995) Study on the embryofeto-toxicity of citral in the rat. Toxicology, 96, 105-113.

Substance Name	Citral
CAS	5392-40-5
Remarks for Substance	Substance supported under SIDS. Commercially available citral. Purity > 90%. Isomeric distribution of approximately 35% neral and 55% geranial.
Method/guideline	Not given
GLP	No
Year	1989
Species/Strain	Rat/Sprague-Dawley
Sex	Female
Route of administration	Inhalation
Duration of test	20 days
Doses/concentration levels	0, 10, 35 ppm as vapor or 85 ppm as aerosol/vapor

Exposure period	6 hr/day on gestational days 6-15
Frequency of treatment	Daily
Control Group and treatment	Yes
Remarks for test conditions	Pregnant Sprague Dawley rats were exposed via inhalation to 0, 10, 35, or 85 ppm citral for six hours a day on gestational days 6-15. Dams were sacrificed on day 20. Fetuses were examined for gross, visceral and skeletal malformations.
NOAEL(NOEL) maternal	35 ppm
LOAEL(LOEL) maternal	85 ppm
NOAEL (NOEL) developmental toxicity	85 ppm
LOAEL (LOEL) developmental toxicity	None reported
Actual dose received by dose level and sex	10.2 +/- 0.9 ppm, 34.4 +/- 4.1 ppm, 68 ppm (30.7 +/-4.2 ppm citral aerosol and 37.0 +/-14.1 ppm citral vapor)
Maternal data with dose level	At the 85 ppm dose level, a statistically significant ($p<0.05$) difference in maternal weight gain for the dosed compared to the controls was reported. Additional signs of clinical toxicity were also reported. No toxicity was reported for the animals receiving 10 or 35 ppm citral.
Fetal data with dose level	No exposure related effects were reported on corpus lutea, implantations or resorptions, nor for fetal viability, litter size, sex ratio and body weight. No exposure related malformations were reported. The incidence of hypoplastic bones (lumbar and pubis) was increased slightly compared to the controls at the highest maternal dose level.
Statistical evaluations	Yes, ANOVA (F-test) and Fischers exact
Remarks for results	Citral administered via inhalation produced no teratogenic effects in rats at the dose levels tested.
Conclusion remarks	Citral administered via inhalation produced no teratogenic effects in rats at the dose levels tested.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study.
References	Gaworski C.L., Vollmuth, T.A., York R.G., Heck J.D., Arany C. (1992) Developmental toxicity evaluation of inhaled citral in rats. Food Chemical Toxicology, 30 269-275.